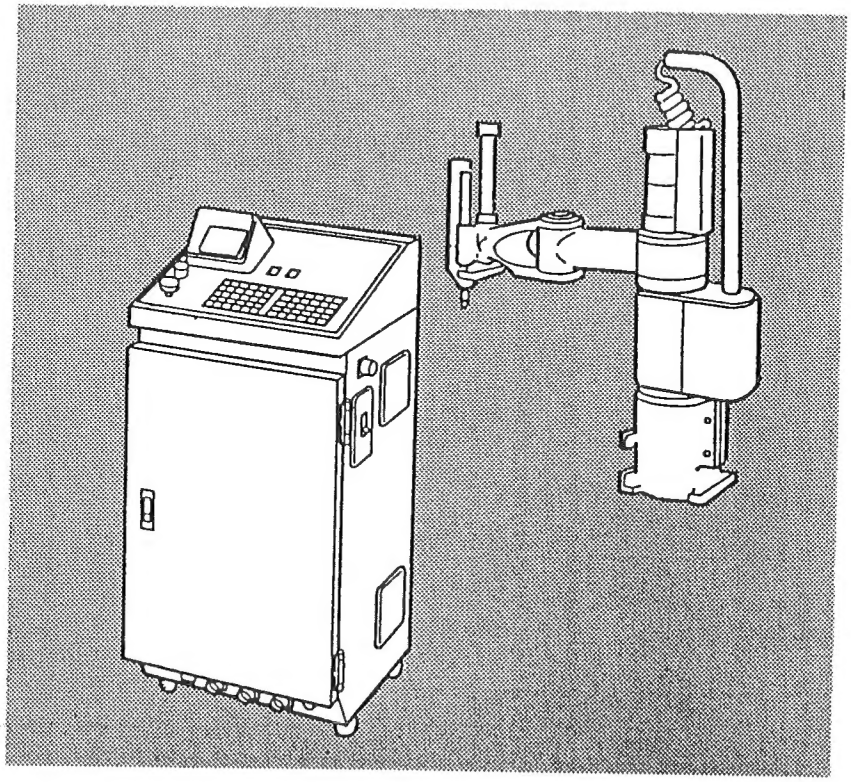
MAKER 11

Operation

Manual



Compact Scara Manipulator

90003-01

etsi™

MAKER 11

USER'S MANUAL

CHAPTER

INTRODUCTION

- The unique ~~Maker 11~~ YK-5012 Robot was designed by ~~United States Robots~~ YAMAHA MOTOR CO. to meet the following two purposes:

  (1) to provide automatic assembly procedures or processes, and

  (2) to reduce assembly cost.

  This Robot is fully articulated embodying information based upon thousands of actual applications on ~~robotic~~ YAMAHA assembly lines.

- **The Maker 11 consists of a manipulator with the first arm (X-axis), the second arm (Y-axis) and a controller with a built-in microprocessor.**

  It has optional vertical movement: 3rd joint (Z-axis) and rotation: 4th joint (R-axis) of the wrist with DC motor combined servocontroller. These options make four-axis movement possible.

  In this way, the Robot can perform diverse assembly line procedures including the following and many other functions.

  1. tightening of fasteners or fixtures;
  2. inserting and pressing of pins and bearings;
  3. dispensing of sealants;
  4. packing or packaging;
  5. installing; and
  6. a variety of other jobs.

This manual carries the following information on the Maker 11 Assembly Robot

1. Installation/Setup Procedures
2. Operation Procedures
3. Programming
4. Periodic maintenance.

Please read this manual thoroughly before installing and operating the Robot.

CHAPTER 1
SAFETY INFORMATION

CHAPTER 2
INSTALLATION

CHAPTER 2
INSTALLATION

In order to set up (and install) the Robot correctly and safely, you must follow the procedures and safety information as given in Chapter I and this chapter.

2-1 CRATES

2-1-1 HANDLING

You will find the following pictograms on the crate sides. Carefully read the explanation of these pictograms for handling the crate.

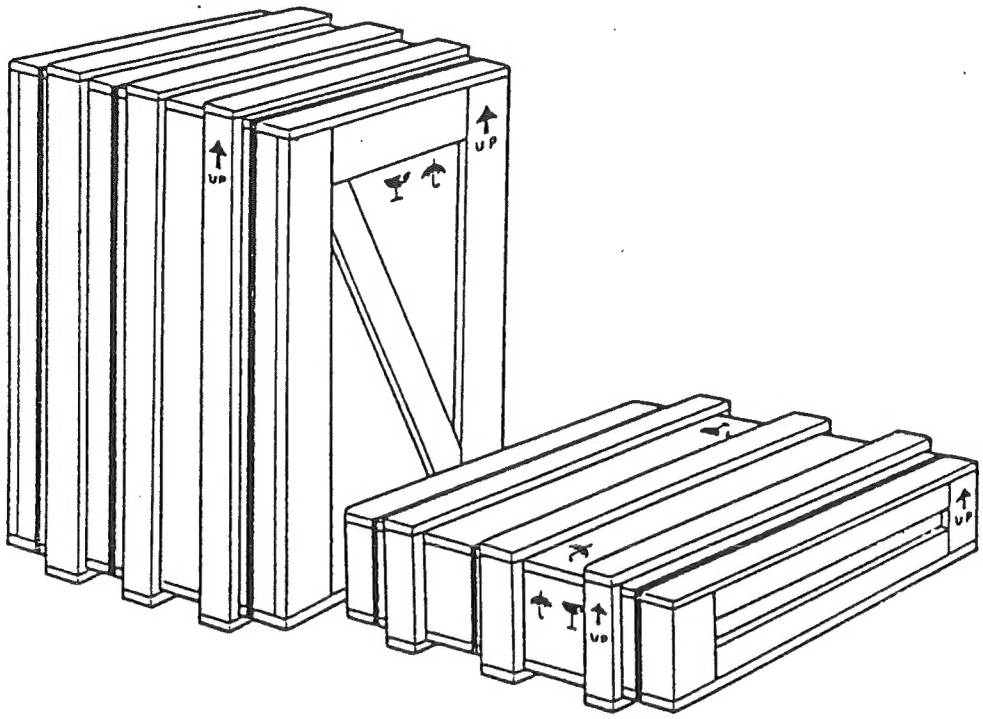
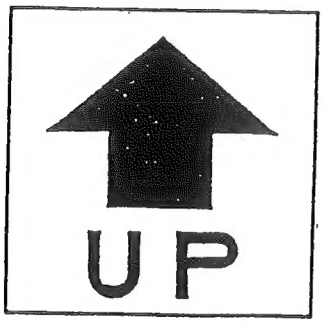
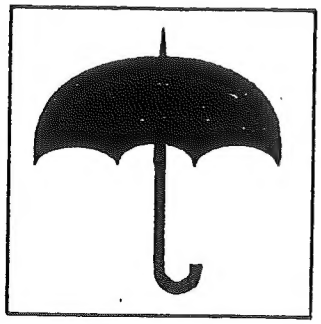


FIG. 2-1. Pictograms on Crates

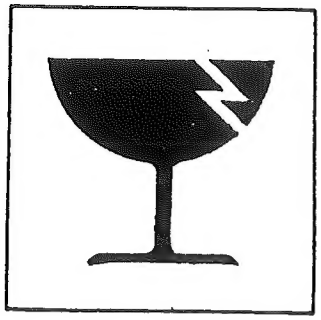
Handling Pictograms



- This arrow indicates the crate top. Be sure to load, unload, or store the crate with this arrow pointed upward.



- This umbrella indicates that the crate should be kept dry. Also avoid excessively humid places for storage.



- This glass indicates that the crate content is fragile. Do not drop the crate or subject it to sharp bumps or shocks.

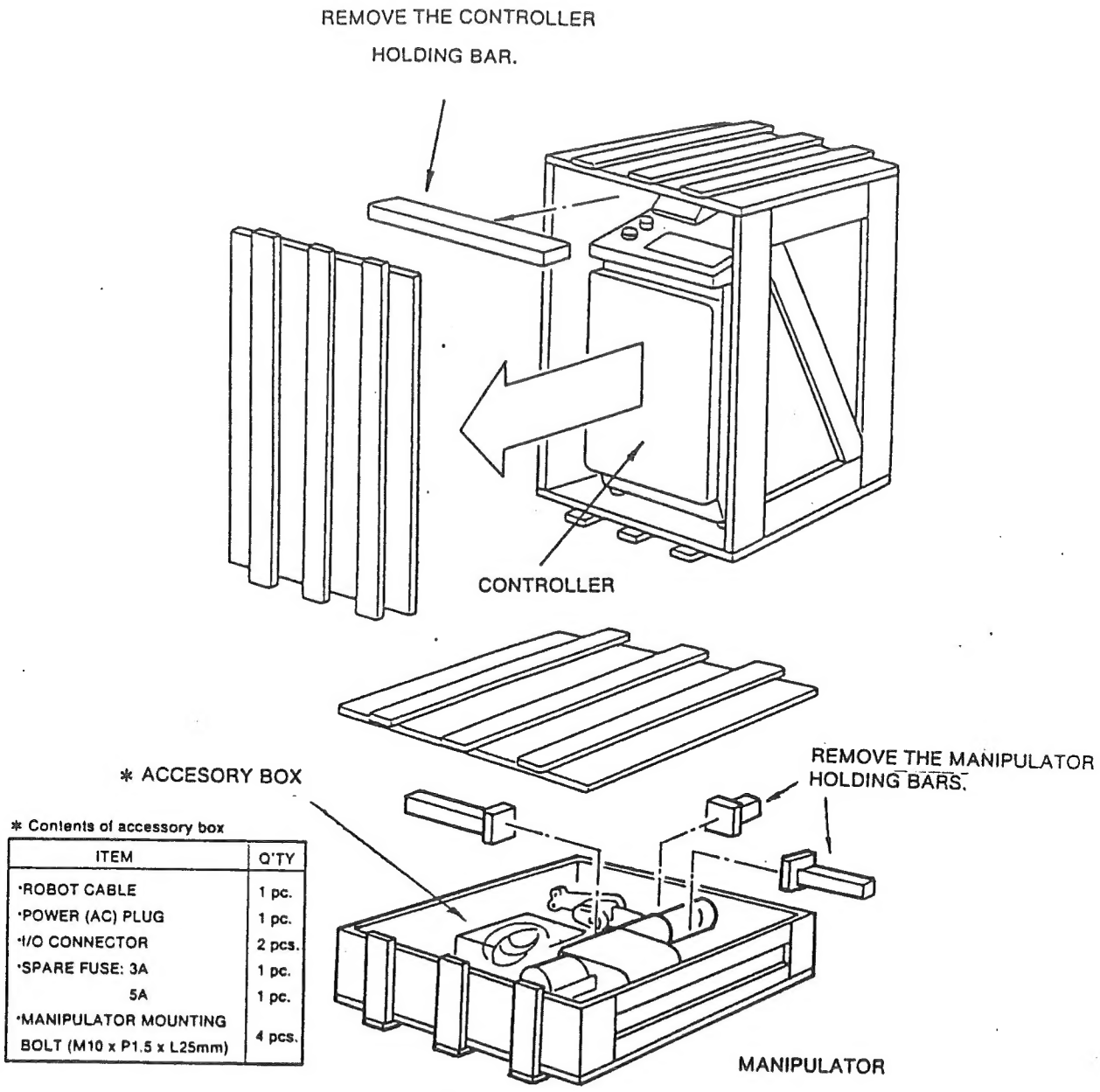
2-1-2 TRANSPORTATION

Observe the following for transporting the crate.

a. While moving or transporting the crate, take special care not to drop or bump it.

b. Select a level, dry, and well-ventilated place for storage.

2-1-3 UNPACKING



* Contents of accessory box

ITEM	Q'TY
•ROBOT CABLE	1 pc.
•POWER (AC) PLUG	1 pc.
•I/O CONNECTOR	2 pcs.
•SPARE FUSE: 3A	1 pc.
5A	1 pc.
•MANIPULATOR MOUNTING BOLT (M10 x P1.5 x L25mm)	4 pcs.

FIG. 2-2. Unpacking

a. The Maker 11 Robotic System is shipped in two separate crates (or three crates if options are included). One crate is for the controller and the other for the manipulator, connection cable, and other parts.

b. Carefully take out all components from the crates and inspect them for damage. If any damage is found, immediately report the detail of the damage to the carrier and your distributor.

2-2 INSTALLATION

2-2-1 PRECAUTIONS

a. As the Robot weighs approximately 32 kg (70 lbs), which can be handled by one adult, we recommend you to use a hoist when installing or working with it. (Refer to FIG. 2-3.)

CAUTION:

Be sure that the belt does not slide beyond the 2nd joint. This will cause damage to the 2nd joint.

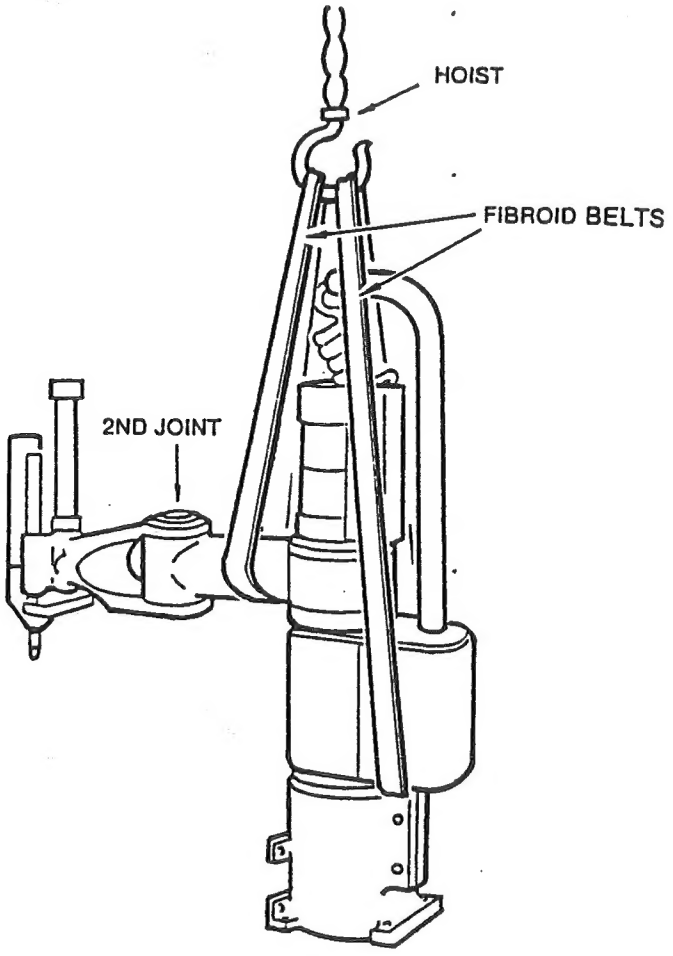


FIG. 2-3. Using a hoist

b. The manipulator must be securely installed by the four (4) mounting bolts (Hex socket head: M10 x P.1.5 x L 25 mm) as the manipulator generates high torque which should react against the mounting base.

2-2-2 MANIPULATOR INSTALLATION

1) Drill and tap four holes of proper size into the manipulator mounting base with the following dimensions as a mounting guide.

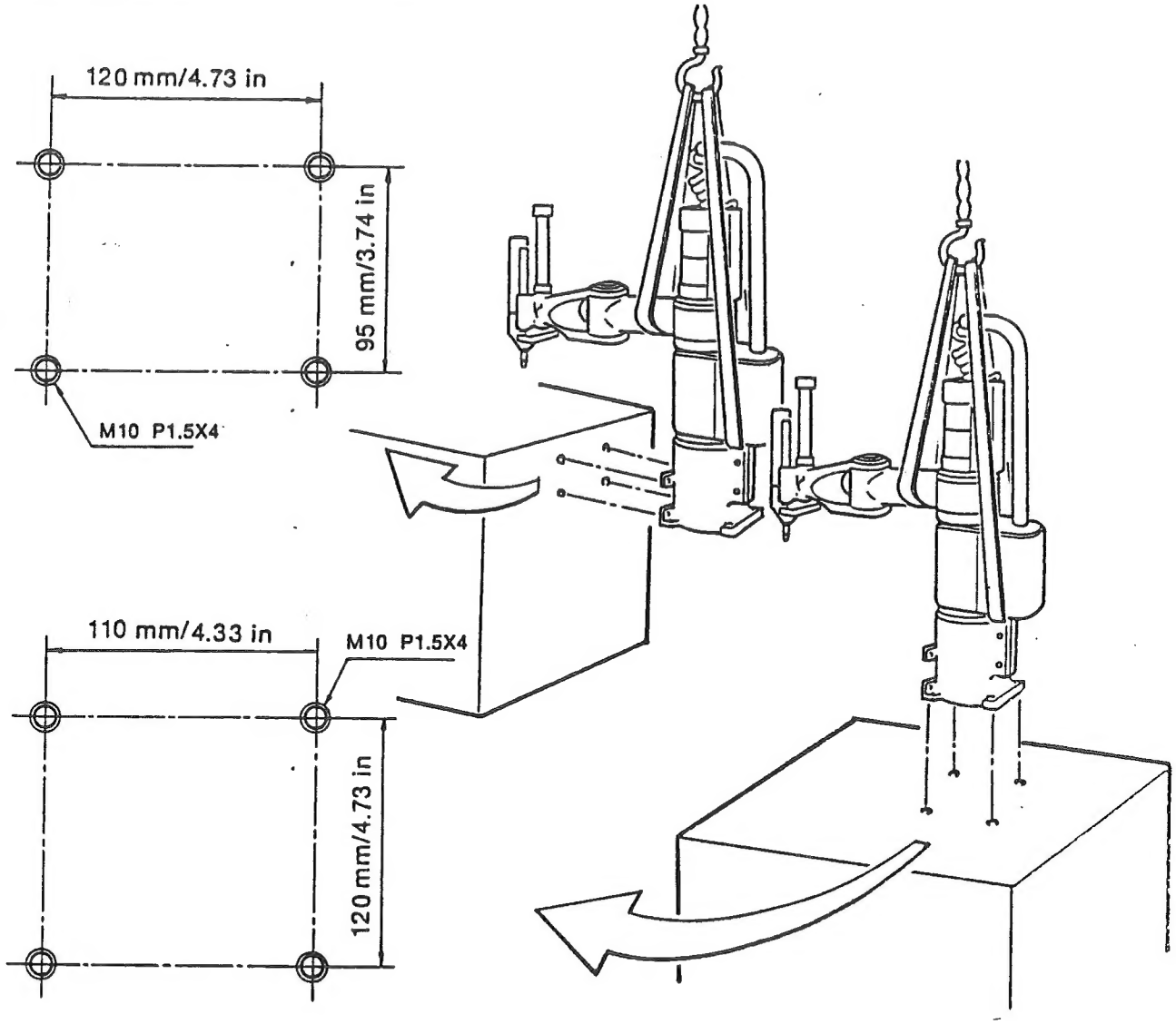


FIG. 2-4. Guide for Mounting Dimensions

2) Install the manipulator onto the mounting base with the four (4) bolts (provided) and tighten them as specified.

Mounting bolt tightening torque: 500 kgf·cm

WARNING:

The mounting bolts should be tightened correctly. If not, the manipulator may loosen during operation resulting in serious damage to the Robot and/or injury to the operator.

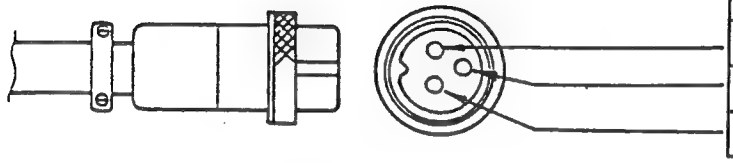
2-2-3 CONTROLLER SET UP

CAUTION:

- **The controller is a very sensitive unit. When moving it, extreme care should be taken not to damage the unit or give it a strong shock or vibrations.**
- **When moving the controller on a forklift, take care not to damage the connectors on the controller front.**
- **The controller is provided with casters. However, do not use these casters for normal transportation. Use them for final position adjustment. Take care not to upset the controller when moving it.**
- **Lock all four casters after the final positioning. Also be sure there is enough space (more than 100 mm or 4 in.) left on the right side for a proper heat dissipation.**
- **Install the controller out of the range of manipulator operation but as close to the unit as possible.**
- **When installing the controller in a bad working environment (e.g., subjected to dust, water, oil, mist, etc.), have your distributor install the indirect cooling unit (option).**

a. Connection of Manipulator and Controller

1) Power plug
Connect the Robot to the mains using the provided plug. Designations and pin numbers for the plug are shown in the table bellow.



PLUG	SIGNAL	WIRE SECTION
1.	AC IN	14 AWG
2.	Ground	14 AWG
3.	AC IN	14 AWG

FIG. 2-5. Power plug

2) Power Source Specification
2 AXES (2 motors) TYPE ..... 2.5 KVA or more
3 AXES (3 motors) TYPE ..... 3.0 KVA or more
4 AXES (4 motors) TYPE ..... 3.5 KVA or more
120V or 240V AC Single phase
50 or 60 Hertz

NOTE:
The power source should always be stable within 10% tolerance.

3) Connection of Controller

Connect one end of the Robot Cable to the connector "ROBOT 1" located in the lower front of the controller and the other end to the manipulator.

NOTE:

- **Be sure that the cables between the manipulator and the controller are connected properly.**
- **When using the teach pendant or the external memory unit, connect the cables to the 24-pin "EXT" connector on the upper right of the controller. (Refer to Chapter 8 "OPTIONS.")**
- **For the I/O CN (connector) 1 and I/O CN (connector) 2, refer to the input and output interface in Chapters 6 "INPUT/OUTPUT INTERFACE."**
- **When the Robot is operated for the first time, various initial adjustments have to be made. Refer to the chapters 4 "OPERATION", 6 "INPUT/OUTPUT INTERFACE" and 7 " ROBOT ADJUSTMENT".**

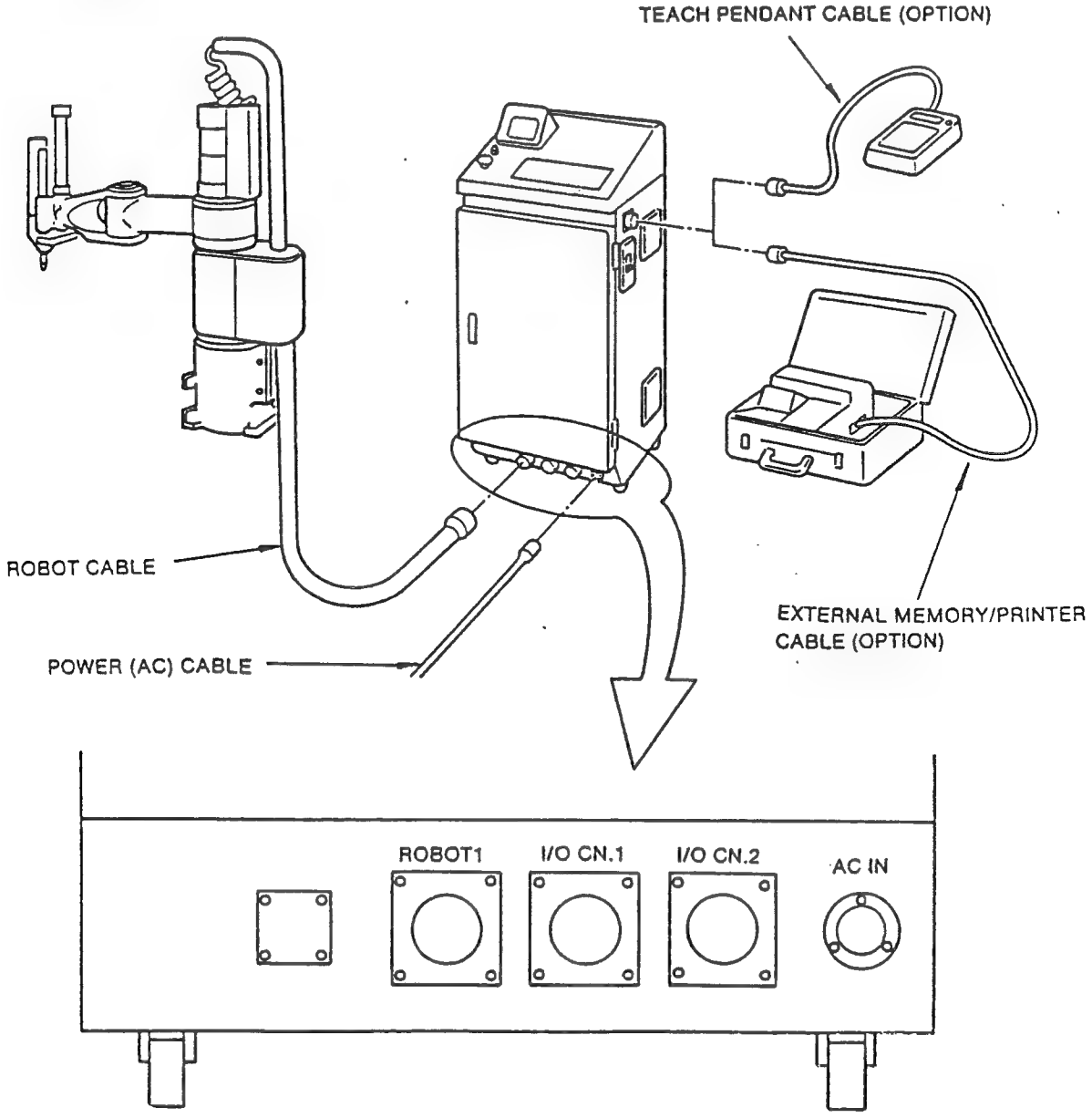


FIG. 2-6 Connectors on Controller

CHAPTER 3
CONTROL FUNCTION

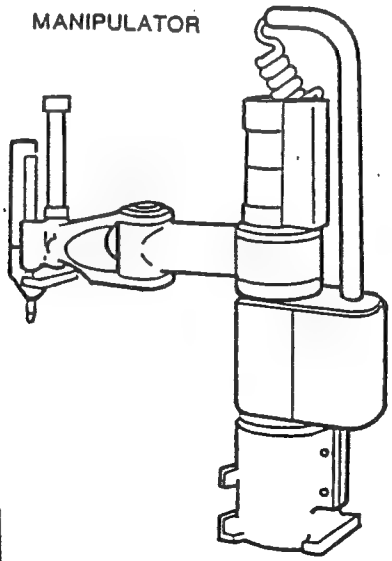
CHAPTER 3
CONTROL FUNCTIONS

3-1 SYSTEM DESCRIPTION

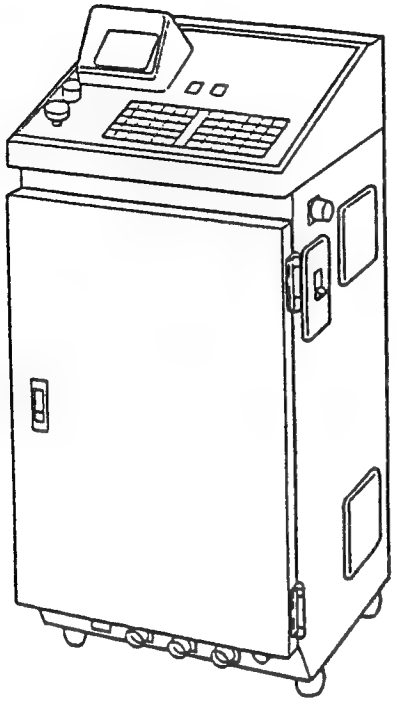
The Maker YK-5012 assembling Robot consists of the following major parts.

3RD AND 4TH JOINTS
(Z-AND R-AXES) OPTION

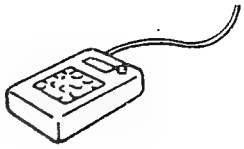
MANIPULATOR



CONTROLLER



TEACH PENDANT (OPTION)



EXTERNAL MEMORY STORAGE AND
PRINTER (OPTION)

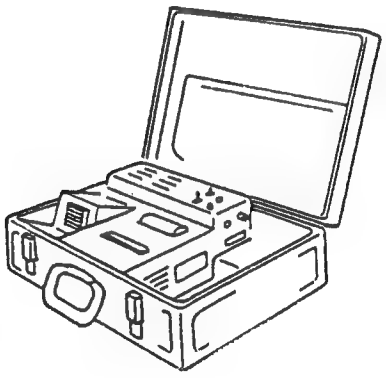


FIG. 3-1. Robot System

3-2 MANIPULATOR

The MANIPULATOR comprises the MAIN BODY (corresponding to the human body), the 1ST/2ND ARMS (X/Y-axes) (corresponding to the human arms), the 1ST/2ND JOINTS and 3RD/4TH JOINTS (Z/R-axes) (corresponding to the human hands).

It can perform the following movements and do the specified variety of jobs with accuracy on the tool fitted to the 3rd or 4th joint (Z or R-axis).

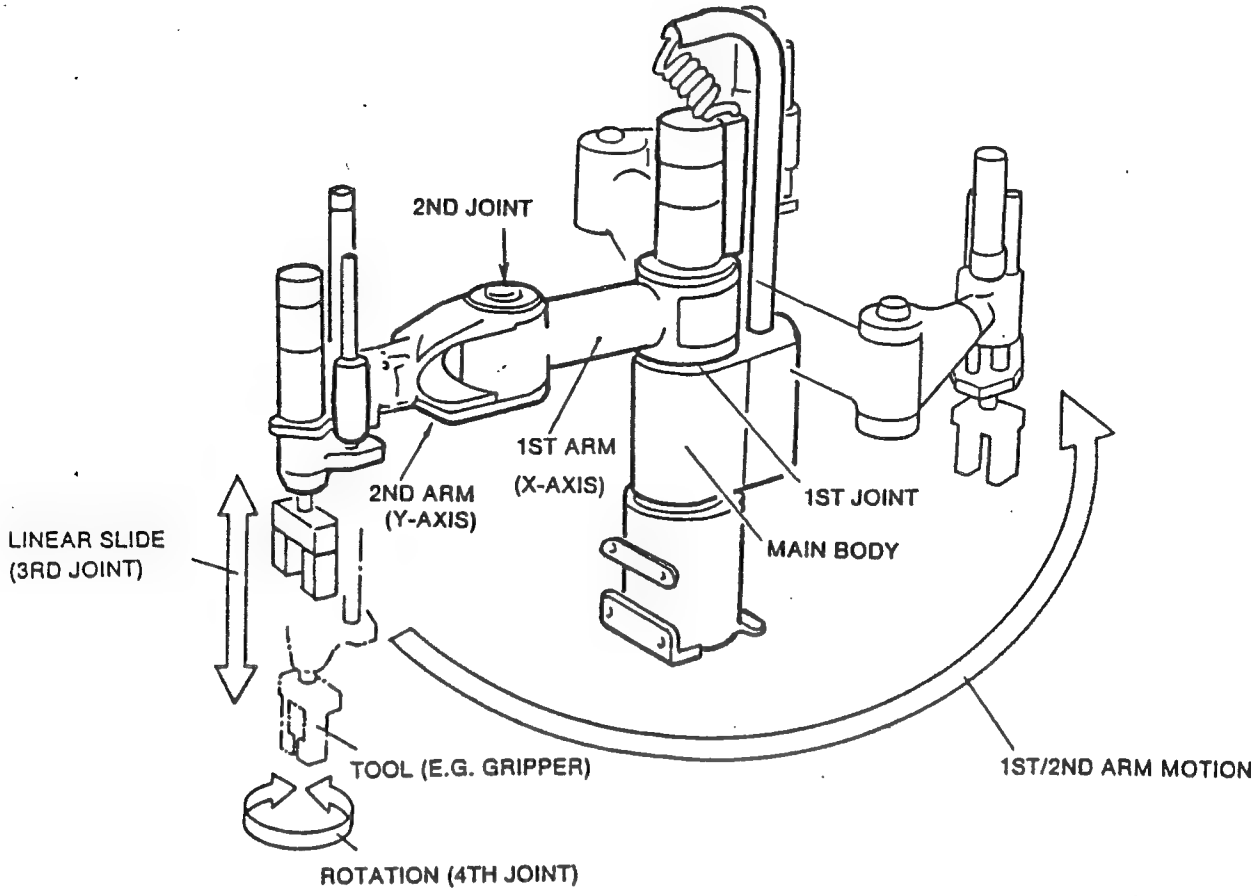


FIG. 3-2. Manipulator

3-3 3RD AND 4TH JOINTS (Z-AND R-AXES) OPTIONS

Install the 3rd joint (Z-axis) and/or the 4th joint (R-axis) with tools for the robot to manipulate for the specified job. (See FIG. 3-3.)

Combinations (option) of the 3rd joint (Z-axis) and 4th joint (R-axis) are listed in the table below.

Combination No.		1	2	3	4	5	6	7	8
3rd joint (Z-axis)	Air cylinder	–	o	–	–	o	o	–	o
	DC motor	–	–	o	–	o	–	o	o
4th joint (R-axis)	DC motor	–	–	–	o	–	o	o	o

NOTE:
In case of combination 7 or 8, use a controller with RCS41 specification for controlling the 3rd and 4th joints (Z and R axes) with DC motor specifications.

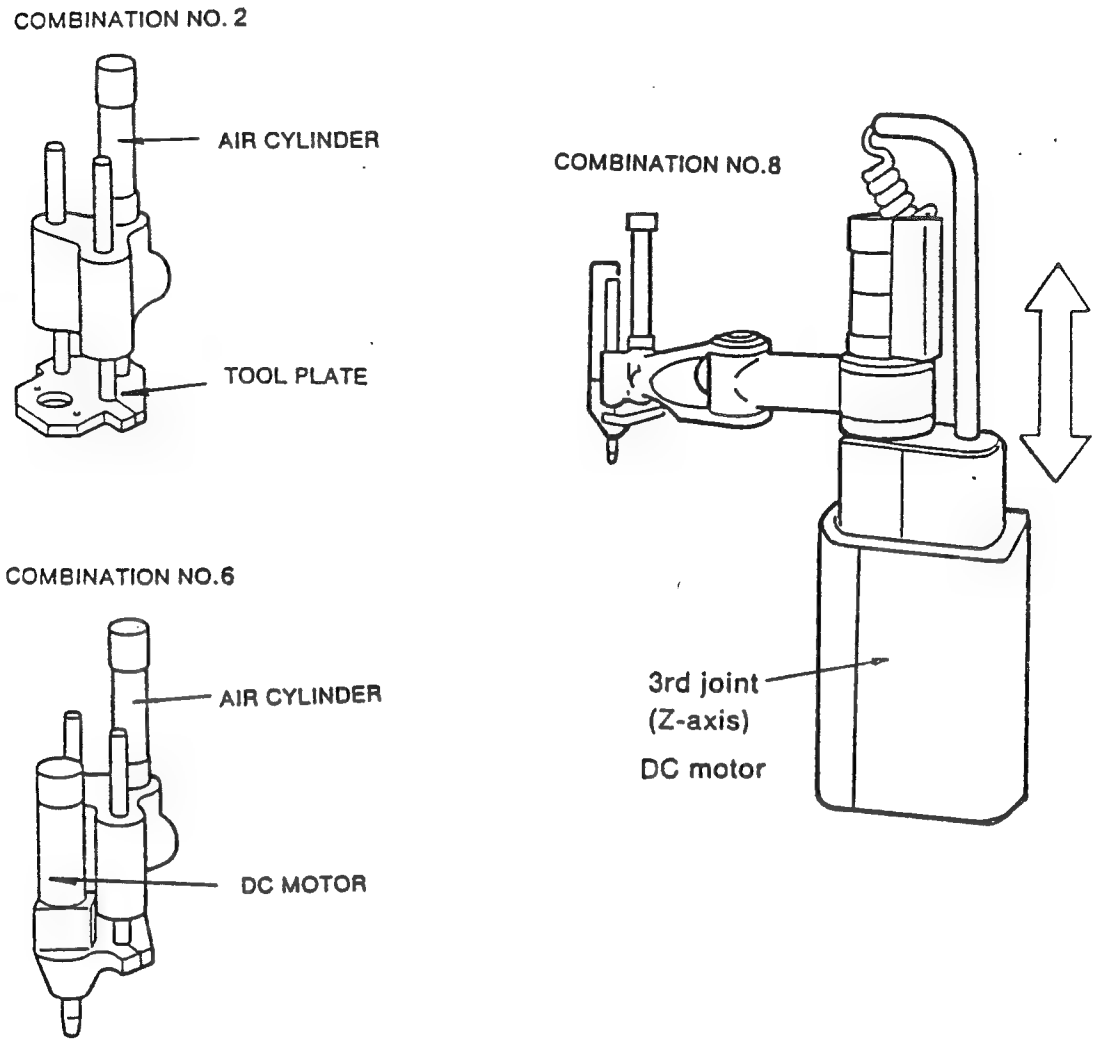
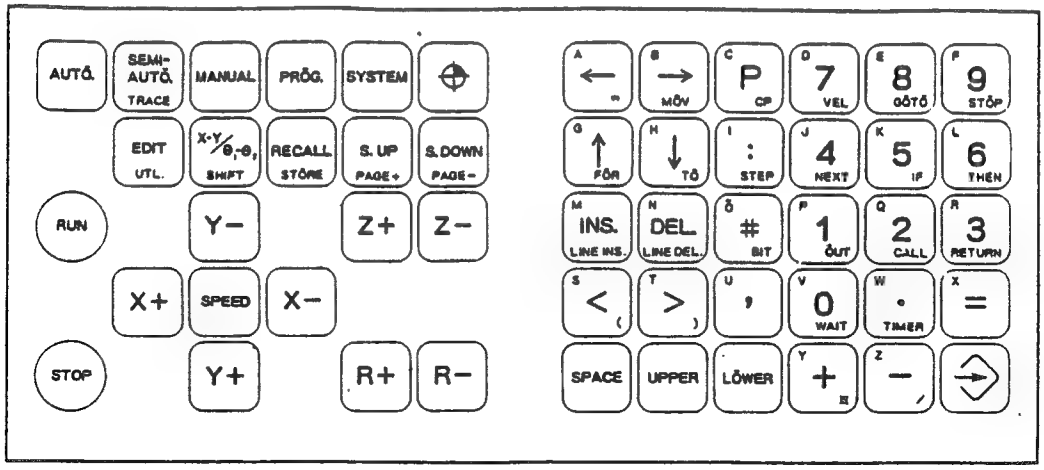


FIG. 3-3 Example of Combinations

3-4 CONTROLLER

The controller is the brain of this Robot system. It consists of a microprocessor which acts as interpreter to convey instructions to the manipulator, control keys (sheet type) which send the instructions, and a screen (CRT) which displays the instructions, the conditions of the manipulator, etc. (For details, refer to Chapter 4 "OPERATION".)

Control Keys (Sheet type)



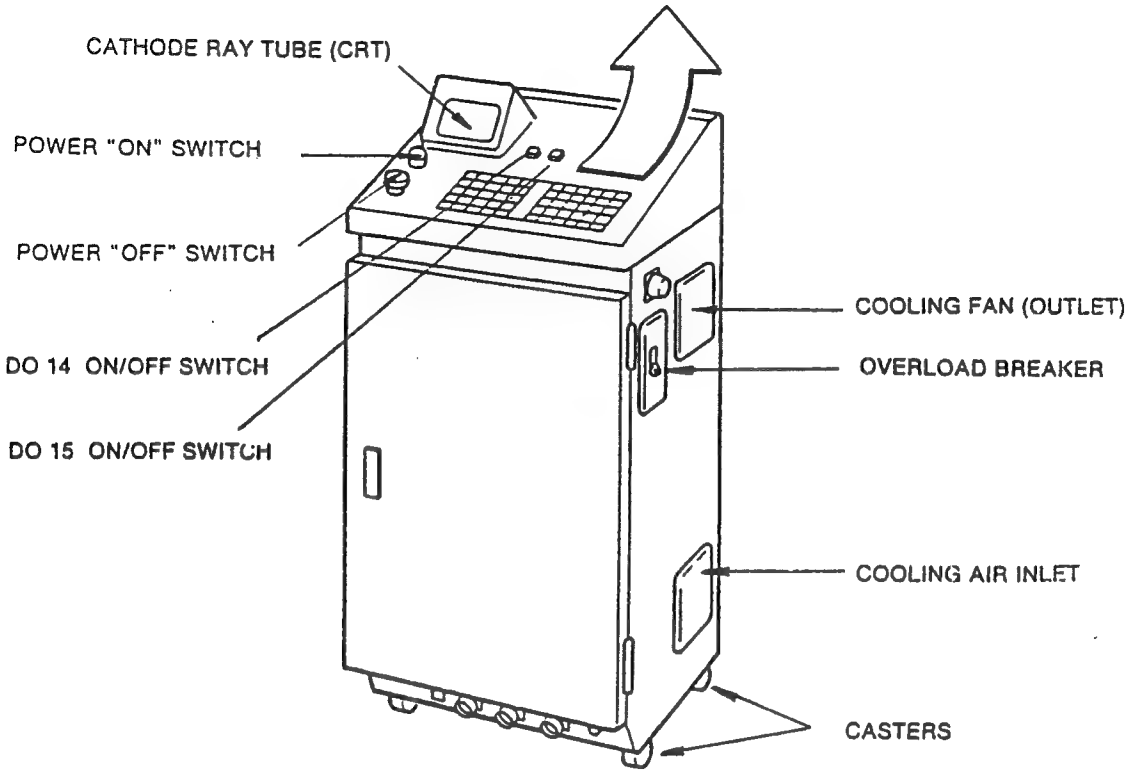


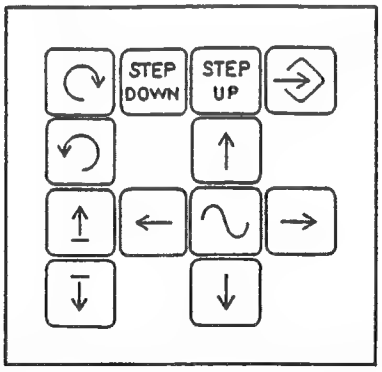
FIG. 3-4 Controller

3-5 TEACH PENDANT (OPTION)

The teach pendant has an arranged set of keys; by which the operator, can teach the Robot system necessary information and data from near the manipulator. (For details, refer to Chapter 5 "PROGRAMMING".)

NOTE:
The teach pendant is for teaching purposes alone; it cannot be utilized for operational instructions.

TEACHING KEYS (SHEET TYPE)



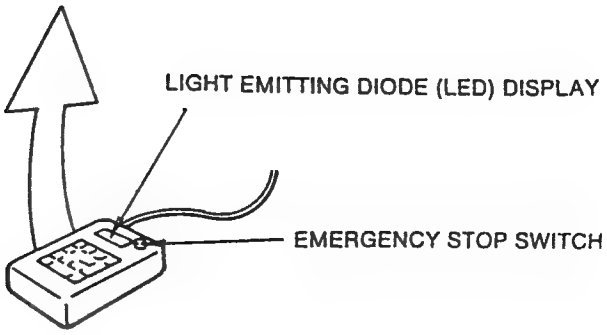


FIG. 3-5. Teach Pendant

3-6 EXTERNAL MEMORY STORAGE AND PRINTER (OPTION)

3-6-1 EXTERNAL MEMORY CASSETTE (BUBBLE MEMORY CASSETTE)

The bubble memory has the following features:

a. Non-volatile memory. (Memory maintained if power is lost.)

b. Easy to rewrite capability.

c. Small, lightweight, and low power requirements with no moving parts.

The External Memory Cassette encases the bubble memory for environmental protection against dust, vibrations, etc.

3-6-2 PRINTER

This is a line-dot mini-printer with the following features:

a. Printing head of a long service life.

b. High speed printing of 80 characters per second.

c. Very clear print out.

d. Low noise.

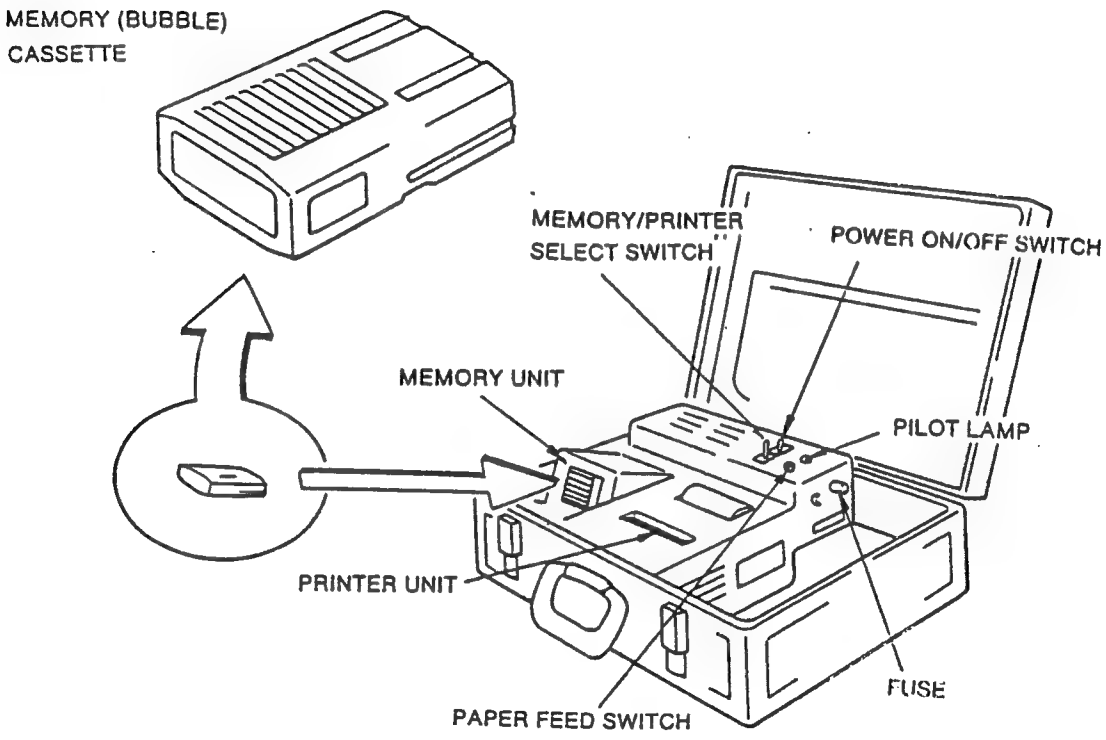


FIG. 3-6. External Memory Storage and Printer

CHAPTER 4
OPERATION

CHAPTER 4
OPERATION

4-1 DESCRIPTION

This Chapter explains various operation methods using the control keys (or the keys on the teach pendant) as well as the contents that will appear on the display.

Operation of the Robot is divided into the following FIVE MODES.

a. MANUAL MODE:
Each arm and joint can be moved independently. Movement of the arms and joints continues as long as the arm and joint operation key is touched. "Return To Home (Origin) Position" can be performed only in the Manual Mode.

b. OPERATION MODE:
User programs can be run in 3 types: Automatic, Semi-Automatic, and Trace.

- Automatic is used for consecutive running of the user programs.
- Semi-Automatic and Trace allow the programs to be run by one command for each touch on the start key. This is mainly used to confirm the operation.

NOTE:
In the Operation Mode the arms and joints can only be moved by running the program. The manual operation keys are inoperable in this mode for safety reasons.

c. SYSTEM MODE:
Tasks common to the respective modes can be performed; i.e., correction of various parameters, checking of entered programs, use of external memory units (bubble cassettes), initializing of the memory, etc.

d. PROGRAM MODE:
User programs can be written and modified. The contents of the program can edited on the screen (screen editor). Screen scrolling and Page Up/Down functions are performed by touching the dedicated keys. This Mode is also provided with utility functions such as Rename, Copy, Erase, etc. of the programs.

e. POINT DATA MODE:
Data common to the respective programs can be written and modified. As in the Program Mode, the Point Data appear on the screen, where they can be edited. Besides, the necessary points can be easily displayed on the screen by making use of the Scroll and Page functions.

- Point numbers from 0 to 999 can be entered.
- Point data can be put into any point number.

- Besides MDI (Manual Data Input) of point data, teaching can be performed. That is, after moving the arm and joint to the desired position, touching the " ⇨ " key causes the data of that point to be set as the data for the designated point number.
- Utility functions are provided for copying point data to a point having a different number, erasing unnecessary point data, etc.

NOTE:
For further details of the Program Mode and Point Data Mode, refer to Chapter 5 "PROGRAMMING."

The Robot can be operated along 2 types of coordinates:

- JOINT COORDINATES; and
- X-Y COORDINATES.

If the X-Y Coordinates have been selected, the coordinates can be shifted according to the position of the work. For SHIFT, other parallel and rotational shifts are possible. When this function is used, point data settings can be less because the same point data can be used for the work at a different position.

If the X-Y Coordinates are to be used, Standard Coordinates have to be set. Refer to 5.4 STANDARD COORDINATES SETTING and 5.5 SHIFT COORDINATES SETTING.

Error messages are displayed on the screen if errors occur during operation. The error message is cleared on correct operation.

NOTE:
For the first operation subsequent to the installation of the uncrated Robot components, refer to Chapter 7 "ROBOT ADJUSTMENT."

4-2 CONTROL KEYS (SHEET TYPE KEYS)

The Control Keys are on the controller. Robot operations are controlled by these keys, which are of a sheet type which is covered with a plastic sheet for dust protection.

4-2-1 KEY LAYOUT

The Control Keys comprise 2 groups:

- command keys on the left; and
- data keys on the right.

See Figure 4-1.

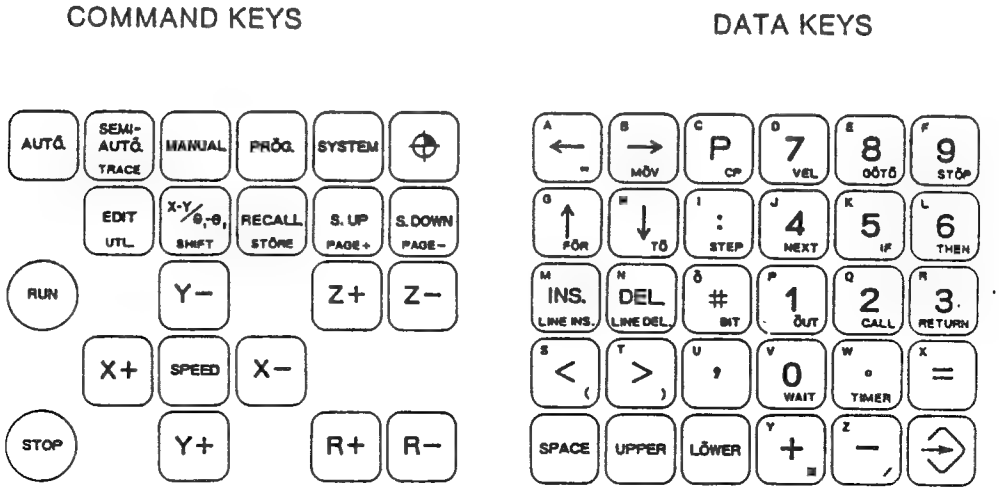


FIG. 4-1 Layout of Control Keys

4-2-2 KEY DESIGNATION

a. One of the keys has three (3) designations. See Figure 4-2.

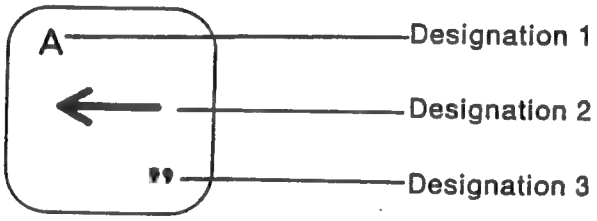


FIG. 4-2 Designations

b. Each key is used in the following manner.

- DESIGNATION 1: The key is touched in combination with the "UPPER" key.
- DESIGNATION 2: The key alone is touched.
- DESIGNATION 3: The key is touched in combination with the "LOWER" key.

See Fig. 4-3

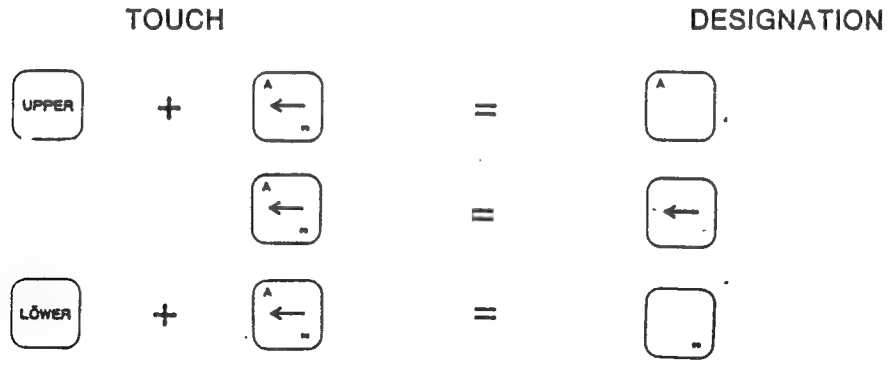


FIG. 4-3 Key Combination

4-2-3 KEY FUNCTION GROUP

The Command Keys are function keys which actuate a particular operation for each key.

The Data Keys are used for all kinds of data input. The " ↵ " key completes the input of a series of data. The others are supplementary function keys.

4-2-3-1 COMMAND KEYS

The Command Keys comprise the Mode Keys, Function Keys, and Operation Keys. The functions of the respective keys are explained below.

a. MODE KEYS

AUTO : selects Automatic Mode.(continuous operation)

SEMI-AUTO : selects Semi-Automatic Mode.(step operation)

TRACE : selects Trace Mode.(step operation with input/output ignored)

MANUAL : selects Manual Mode.

PRÓG. : selects Program Mode.

SYSTEM : selects System Mode.

NOTE:
Point Data Mode is selected by first selecting the Program Mode and then touching the "P" key. P

b. FUNCTION KEYS

: instructs the Return To Home (Origin) Position; effective only in the Manual Mode.

EDIT : begins and completes program editing or editing of Point and Shift Data.

X-Y/θ,-θ, : switches coordinates from Joint to X-Y Coordinates and vice versa.

UTL. : actuates utilities in the following modes.

PROGRAM MODE:. Switch, Rename, Copy, and Erace.

POINT DATA MODE: Copy, and Cancel.

OPERATION MODE: Switch, and Reset.

SHIFT : commences shift coordinate setting. This key becomes a instruction word key during editing in the Program Mode.

S. UP : Scroll Up/Step Up: In the Program or Point Data Mode, this key is used for scrolling up the screen, whereas in the Operation Mode (Automatic, Semi-Automatic and Trace) it has a step-up function.

S. DOWN : Scroll Down: This key is effective only in the Program or Point Data Mode and is used for scrolling down the screen.

PAGE+ : switches to the next screen; effective in the Program Mode, Point Data Mode, and System Mode.

PAGE- : switches to be preceding screen; effective in the Program Mode, Point Data Mode, and System Mode.

SPEED : changes speed. Touching this key causes the speed to change in the order of 3 (low) → 2 (medium) → 1 (high) → 3. During teaching in the Program Mode or Point Data Mode, or during coordinate setting, this key can be used for a high-speed designation if used in combination with the keys "X+", "X−", "Y+", and "Y- ".

c. OPERATION KEYS

RUN : starts operation; effective in the Automatic Mode, Semi-Automatic Mode, and Trace Mode.

STOP : stops operation; effective in the Automatic Mode after the "RUN" key is touched and effective only in the Semi-Automatic Mode and Trace Mode during the performing of a command after the "RUN" key is touched.

X+ : moves the 1st arm (X-axis) in the "+" direction.

X− : moves the 1st arm (X-axis) in the "−" direction.

Y+ : moves the 2nd arm (Y-axis) in the "+" direction.

Y− : moves the 2nd arm (Y-axis) in the "−" direction.

Z+ : moves the 3rd joint (Z-axis) in the "+" direction.

Z− : moves the 3rd joint (Z-axis) in the "−" direction.

R+ : moves the 4th joint (R-axis) in the "+" direction.

R− : moves the 4th joint (R-axis) in the "−" direction.

4-2-3-2 DATA KEYS

These keys are used for data inputting and program writing.

a. ALPHANUMERIC KEYS

0 ~ 9 : Numeric entry.

A ~ Z : Letter entry. (the "P" key is available in key designations 1 and 2, which is used as the same key in both cases.)

SPACE : Space entry.

b. SYMBOL KEYS

: # < > ( ) ' . = + − " /

c. CURSOR KEYS (arrow marks)


: moves the cursor to the left.


: moves the cursor to the right.


: moves the cursor upward. When the screen is not being edited, touching this key moves the "*" mark or the reverse number display upward.


: moves the cursor downward. When the screen is not being edited, touching this key moves the "*" mark or the reversenumber display downward.

d. EDIT KEYS

: inserts one character at the cursor position.

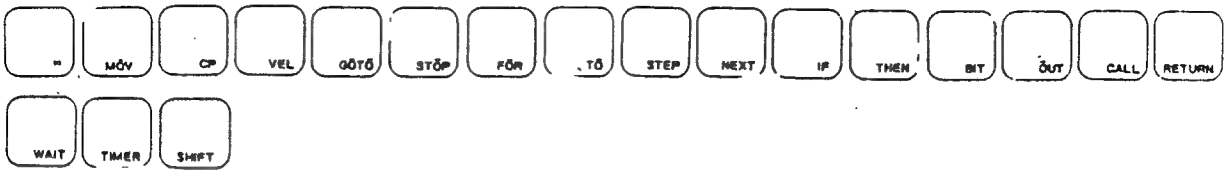
: deletes one character at the cursor position.

: deletes the whole line on the cursor.

: inserts lines, effective only in the Program Mode; switching to and cancelling the continuous line insertion mode.

e. INSTRUCTION WORD KEYS

These keys are used for program writing. Refer to 5.6 "ROBOT LANGUAGE" for details.



4-2-3-3 OTHER KEYS AND SWITCHES

: recalls the data stored in the line buffer to the cursor line; effective only when the cursor is displayed.

: stores the cursor line data in the line buffer; effective only when the cursor is displayed.


: Point teaching. When the cursor is displayed, this key completes entry of the cursor line data.

: selects the key designation 1.

: selects the key designation 3.

: Power "ON" switch.

: Power "OFF" switch.

: Over load breaker.

: DO14 (output) ON/OFF Switch.

: DO15 (output) ON/OFF Switch.

– MEMO –

4-3 TEACH PENDANT KEYS

The control keys on the teach pendant are also of the sheet type and are used to teach the working points.

These keys become effective when the letter R is touched while in the Program Mode or Point Data Mode.

NOTE:
The teach pendant is provided only with the keys necessary for point data teaching.

4-3-1 KEY LAYOUT

The 12 keys are laid out as in the following figure.

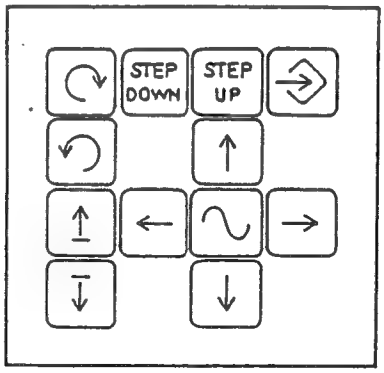


FIG. 4-4 Layout of Teach Pendant Keys

4-3-2 KEY FUNCTION GROUP

The teaching keys are grouped into function keys and operation keys.

4-3-2-1 FUNCTION KEYS

These keys are used for teaching the Robot.

STEP UP : moves the "*" mark upward in the Program Mode and the reverse display number upward in the Point Data Mode.

STEP DOWN : moves the "*" mark downward in the Program Mode and the reverse display number downward in the Point Data Mode.

: changes the speed. Touching this key causes the speed to change in the order of 3 (low) → 2 (medium) → 1 (high) → 3. Use this key together with the "←", "→", "↑", "↓" keys for high-speed designation.

: used for point teaching. This key teaches the current point data to the command marked "*" in the Program Mode and to the point number of the reverse display in the Point Data Mode.

4-3-2-2 OPERATION KEYS

These keys are used for manual arm operation.

 : moves the 1st arm (X-axis) in the "+" direction.

 : moves the 1st arm (X-axis) in the "−" direction.

 : moves the 2nd arm (Y-axis) in the "+" direction.

 : moves the 2nd arm (Y-axis) in the "−" direction.

 : moves the 3rd joint (Z-axis) in the "+" direction.

 : moves the 3rd joint (Z-axis) in the "−" direction.

 : moves the 4th joint (R-axis) in the "+" direction.

 : moves the 4th joint (R-axis) in the "−" direction.

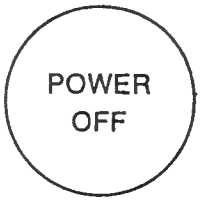
4-4 POWER ON/OFF PROCEDURE

1) After turning on the overload breaker on the right side of the controller (by pulling it), push the switch

on the left of the operator panel of the controller. The illumination lamp lights up, showing the power is on.

2) After turning on the power, the Manual Mode and Joint Coordinate System are automatically selected. Start the operation of the Robot after having performed the Return To Home (Origin) position. (Refer to 4-5-1 "MANUAL MODE".)

3) If you want to turn off the power, push the switch



and all power sources will be cut off. Unless the Robot is used for a longer period of time, set the overload breaker to the OFF position as well.

The POWER OFF switch also functions as an emergency stop key. Push this switch in emergency.

WARNING:

Even if the power is off for the controller, voltage is still applied to part of the controller circuit. Use care when you touch the inside of the controller.

CAUTION:

If "PARAMETER DESTROYED" or "MEMORY DESTROYED" is displayed on the screen when the power is turned on, the Robot cannot be operated correctly without initializing in the System Mode prior to returning to the Home (Origin) Position. (Refer to 4-5-3-4 "INITIALIZE".)

4-5 MODE SELECTION

After turning on the power and returning to the Home (Origin) Position, select the mode by touching each key.

This section explains five modes for operating the Robot as follows.

a. MANUAL:
This is for manual operation. This mode is automatically selected when the power is turned on. You can move the arms and joints manually by touching the "X+", "X−", "Y+", "Y−", "Z+", "Z−", "R+", "R

The Return To Home (Origin) Position can also be performed in this mode.

b. AUTO.:
This is for automatic (continuous) operation. Touch the "RUN" key in the Automatic Mode and the program will be run successively. This is the most commonly used of the normal modes.

c. SEMI-AUTO.:
This is for step-by-step operation. Touch the "RUN" key in the Semi-Automatic Mode and the program will proceed step by step.

This function is used for checking a program, etc.

d. TRACE:
This is for tracing operation (i.e., step-by-step operation which ignores input/output command statements and timer statements). Touch the "RUN" key in the Trace Mode and the program will proceed step by step.

e. SYSTEM:
This is for altering parameters, displaying the program directory or initializing the memory or the parameters.

When you want to change operating conditions such as maximum speed, tip weight, tolerances or first travel (soft) limits, reset the corresponding parameters after selecting this mode.

4-5-1 MANUAL MODE

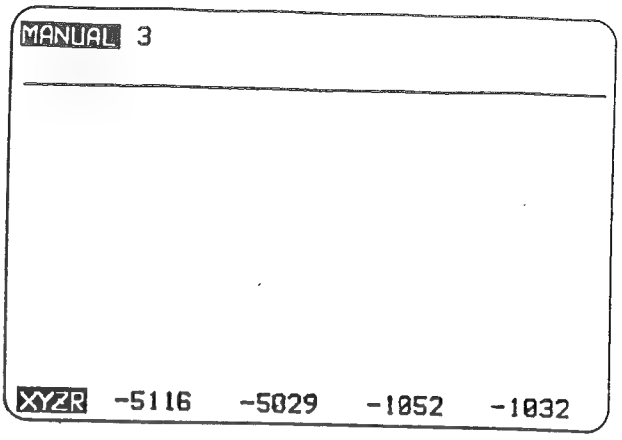
Touch [MANUAL]:

The key selects Manual Mode,

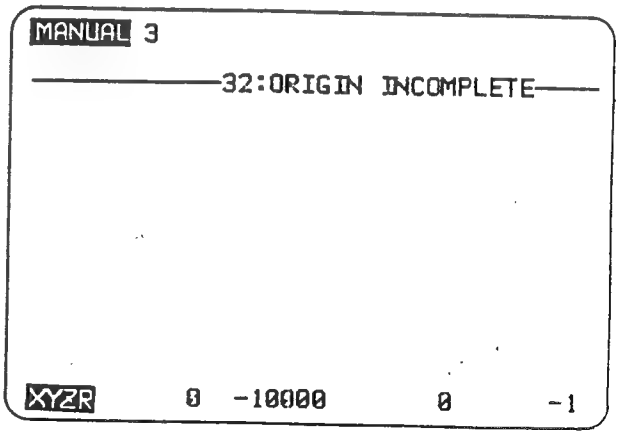
- "MANUAL" appears in reverse display on the upper left of the screen and
- the arm/joint speed is automatically set to low speed (3).

This mode is used for the manual movement of each individual arm/joint.

The numerals at the bottom of the screen shows the current arm and joint positions.



NOTE:
Whenever the power switch is turned on, the Manual Mode is automatically selected and "ORIGIN INCOMPLETE" appears on the upper of the screen.
Then perform the 4-5-1-1 "RETURN TO HOME (ORIGIN) POSITION" procedures.



4-5-1-1 RETURN TO HOME (ORIGIN) POSITION

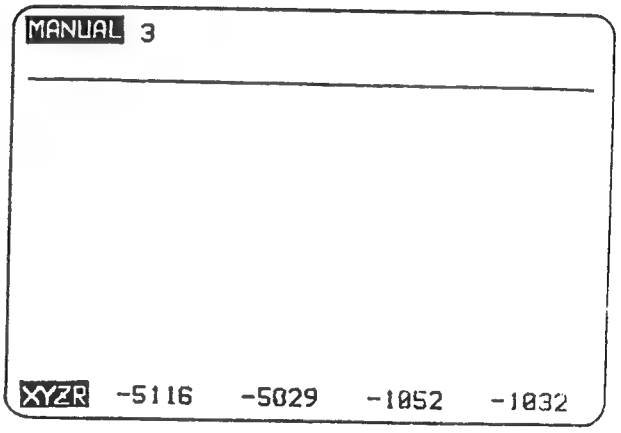
For operating the Robot, it is necessary first to perform the Return To Home (Origin) Position in the Manual Mode, as follows.

1) Make sure that the 1st and 2nd arms are on the "+" side of the origin. If not, move the arms to the "+" side by using manual arm operation keys (Refer to Chapter 7 "ROBOT ADJUSTMENT").

2) Touch [⊕]:

When the Robot returns to the Home (Origin) Position, the message "ORIGIN INCOMPLETE" disappears from the screen.

On return to Home (Origin) Position, the Grid Position is displayed showing the current position on the bottom of the screen.



GRID POSITION: The number of encoder pulses from encoder zero signal until the Home (Origin) Position limit switch is on (a negative value). Refer to 7-3-2 "ADJUSTMENT OF GRID POSITION" for details.

NOTE:

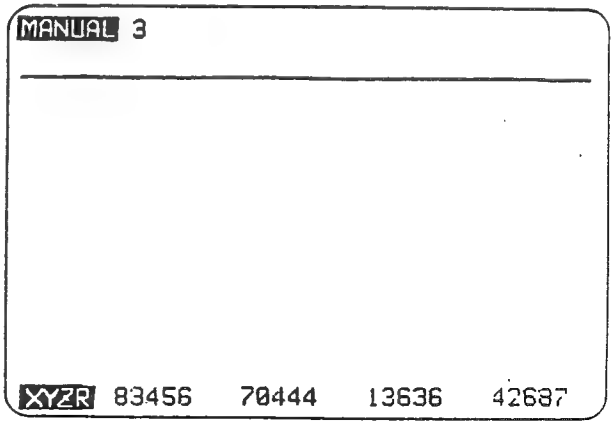
- **If " ⊕ " is touched while either the 1st or the 2nd arm is still on the "−" side, the Robot will move that arm up to the 2nd limit without finding the Home (Origin) Position.**
- **Once the Return to Home (Origin) Position is performed, it is not necessary to perform it again unless the operator turns off controller.**

4-5-1-2 MANUAL ARM OPERATION

Touch [X+], [X−], [Y+], [Y−]:

Each key moves the arms in the system of the Joint Coordinates. The arm keeps moving within the specified range as long as the key is held.

The arm position numerals will change according to Robot movement.



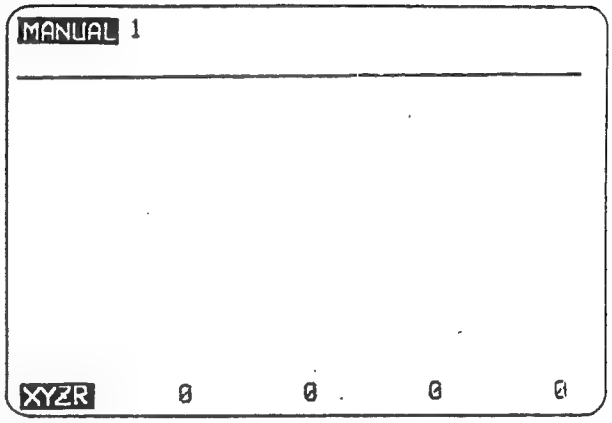
NOTE:

The optional 3rd and 4th joints (Z and R axes) can be moved by touching the "Z+", "Z−", "R+", "R−" keys.

4-5-1-3 ARM SPEED CHANGE

Touch [SPEED]

The key changes the speed of the arm movement. Each touch on this key changes the speed in the order of 3 (low) → 2 (moderate) → 1 (high) → 3.



NOTE:

The speed of the optional 3rd and 4th joints (motor type) can be changed by above key at the same time.

4.5.2 OPERATION MODE (AUTOMATIC MODE, SEMI-AUTOMATIC MODE, AND TRACE MODE)

The Operation Mode has three (3) sub-modes: Automatic, Semi-Automatic, and Trace.

- AUTOMATIC MODE: Touch the "AUTO" key. The command statements are performed consecutively.
- SEMI-AUTOMATIC MODE: Touch the "SEMI-AUTO" KEY. One command statement is performed each time.
- TRACE MODE: This is identical with the Semi-Automatic Mode except that the input/output command statements WAIT, OUT and the timer statement TIMER are ignored.

While in an Operation Mode, UTILITY has the following functions:

1. PROGRAM SWITCHING
2. PROGRAM RESET

PROGRAM SWITCHING allows the operator to select a different program from the controller memory.

PROGRAM RESET initializes the user program so that it can be started from the beginning.

If the program is not reset, it will continue execution from the last step executed.

NOTE:
The program can be reset not only by Program Reset Utility but also the following cases:
1.when the program was switched in the Operation or Program Mode;
2.when the program was erased in the Program Mode;
3.when the program is edited in the Program Mode; and
4.when the STOP statement is performed in the Operation Mode.

- S.UP (STEP UP) FUNCTION is provided to aid in debugging the user programs. By touching the "S.UP" key instead of the "RUN" key, the user programs can be executed while ignoring (skipping) the statements MOV, CP, WAIT, OUT, and TIMER.

The Trace Mode differs from STEP UP in that the MOV and CP statements are performed.

NOTE:
Unless the Return To Home (Origin) Position has been completed, the "RUN" key is inoperable.

NOTE:
If the power switch is turned off while arms are moving in the Operation Mode, PROGRAM RESET must be performed for reoperation.

4-5-2-1 AUTOMATIC OPERATION

Automatic Mode performs the commands of a program consecutively to the end by touching the "RUN" key. This mode is most commonly used in actual operation.

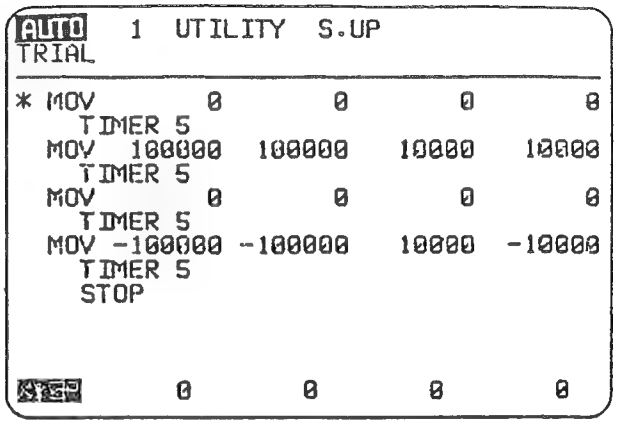
Prior to the Automatic operation it is necessary to perform the program debugging, input/output confirmation, and point data teaching.

Perform the following steps.

1) Touch [AUTO]:

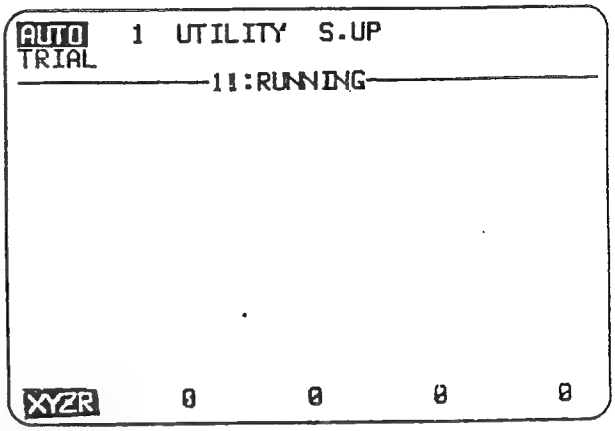
This key selects the Automatic Mode.

- "AUTO." appears in reverse video display on the upper left of the screen.
- The program name and program list are displayed.
- The program last used is selected, and the next command statement to be performed is marked "*".
- By way of checking programs and point date, if an error has occurred, the program cannot proceed.
- Speed is automatically set to 1 (high).
- The bottom of the screen shows the current position.



2) Touch [RUN]:

In the Automatic Mode, the commands are performed consecutively starting with the one marked "*".
The program list disappears and the "RUNNING" message is displayed on the upper of the screen during the Automatic Operation.



4-5-2-2 SEMI-AUTOMATIC OPERATION

Semi-Automatic Mode performs one line of command for each touch on the key.

The external input/output and the program can be checked for matching by line-by-iine operation.

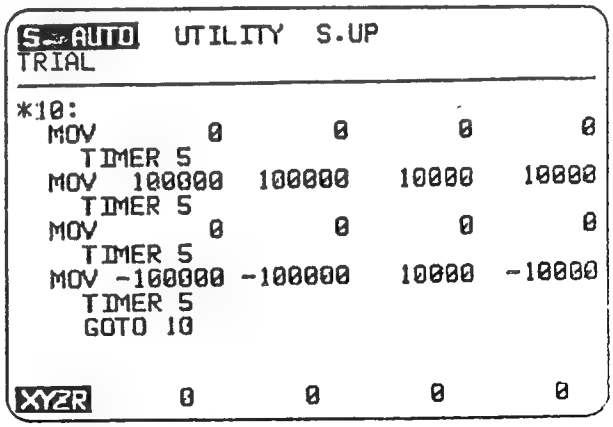
Perform the following steps.

1) Touch [SEMI-AUTO]:

"S. AUTO" appears in reverse video display on the upper left of the screen.

2) Touch [RUN]:

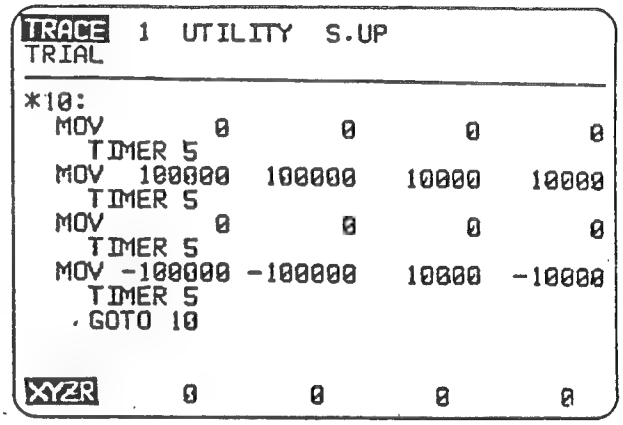
In this Mode, only one line of command with "*" is performed at a time.



Trace Mode performs one line of command for each touch on the key, totally ignoring external inputs/outputs.

1) Touch (TRACE):

"TRACE" appears in reverse video display on the upper left of the screen.



2) Touch (RUN):

This key performs the command marked "*".

In this Mode, the input/output commands WAIT, OUT and the timer command TIMER are skipped.

NOTE:

- **In Semi-Auto and Trace Modes, the "*" mark moves according to the performance of the commands, and the display on the screen is scrolled.**
- **In Automatic Mode, the display on the screen is not scrolled.**

4-5-2-4 STOP

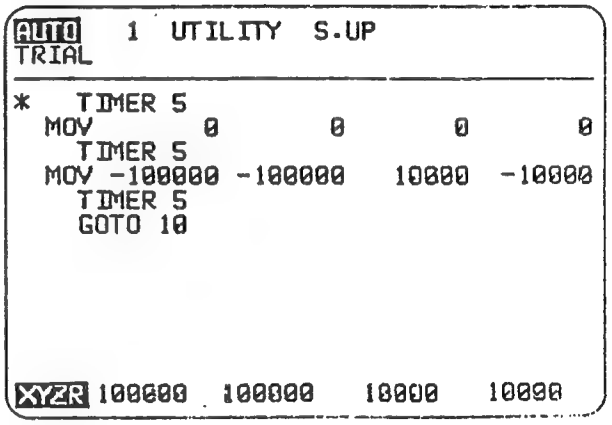
"STOP" key stops performing the program temporarily.

Touch (STOP):

This key stops performance of a command.

- If this key is touched while the arm is moving, it stops the arm at that position.
- Regardless of the mode, the command to be performed next is displayed on the screen together with an "*" mark.

NOTE:
Touch the "RUN" key to start performance again.



4.5.2.5 S.UP (STEP UP)

The S.UP performance checks the commands in the program by one line for each key touch without moving the manipulator.

"ERROR" is displayed for any construction error as shown.

Touch [S.UP]:

This key performs the command marked "*". (Arm movement commands MOV, CP, input/output commands WAIT, OUT and timer command TIMER are skipped). The screen is showing that the construction error ("RETURN WITHOUT CALL") is existing in the "*" marked command line ("RETURN").

```
AUTO   1  UTILITY  S.UP
TRIAL
-----------1:16:RETURN WITHOUT CALL-
*    RETURN
     *
     FOR N=1 TO 10
     P0=PN+P0
     MOV P0
     NEXT N
     STOP
     *
     FOR N=11 TO 20
     MOV PN
     CALL 10

XYZR       0        0        0        0
```

NOTE:
The S.UP performance can be performed in Operation Mode. (Automatic, Semi-Automatic, and Trace Mode)

4.5.2.6 PROGRAM SWITCHING PROCEDURES

The following explains procedures for switching a program in the Operation Mode as well as designating the program name and recalling it.

1) Touch [UTIL.]:

This key actuates utility. A menu appears at the top of the screen.

The screen displays the "TRIAL" program.

```
AUTO   1  1.SWITCH   2.RESET
TRIAL
-------------------------------------
*10:
  MOV        0        0        0        0
    TIMER 5
  MOV   100000   100000    10000    10000
    TIMER 5
  MOV        0        0        0        0
    TIMER 5
  MOV  -100000  -100000    10000   -10000
    TIMER 5
    GOTO 10

XYZR       0        0        0        0
```

2) Touch [1]:

This key selects program switching.

A message and the cursor are displayed, prompting the input of a program name.

```
AUTO   1  PROGRAM SWITCHING
TRIAL     _
-------------------------------------
*10:
  MOV        0        0        0        0
    TIMER 5
  MOV   100000   100000    10000    10000
    TIMER 5
  MOV        0        0        0        0
    TIMER 5
  MOV  -100000  -100000    10000   -10000
    TIMER 5
    GOTO 10

XYZR       0        0        0        0
```

3) Touch [0] ~ [9] and/or [A] ~ [Z]:

This enters a program name (six characters or less).

There are no restrictions on the order of the alphanumeric characters.

The screen shows the "TEST" is entered.

```
AUTO   1  PROGRAM SWITCHING
TRIAL     TEST_

*10:
  MOV        0        0        0        0
    TIMER 5
  MOV   100000   100000    10000    10000
    TIMER 5
  MOV        0        0        0        0
    TIMER 5
  MOV  -100000  -100000    10000   -10000
    TIMER 5
    GOTO 10


XYZR       0        0        0        0
```

4) Touch [→]:

This key completes program name entry and switches to the specified program.

The program is reset (i.e. initialized so that operation can start from the beginning of the program).

The screen displays the "TEST" program after completing the program switching.

```
AUTO   1  UTILITY  S.UP
TEST

* 1:MOV P0
    CALL 10
    FOR N=0 TO 7
    CP PN
    CALL 20
    NEXT N
    ▪
  2:MOV P0
    CALL 30
    FOR N=0 TO 7
    CP PN

XYZR       0        0        0        0
```

– MEMO –

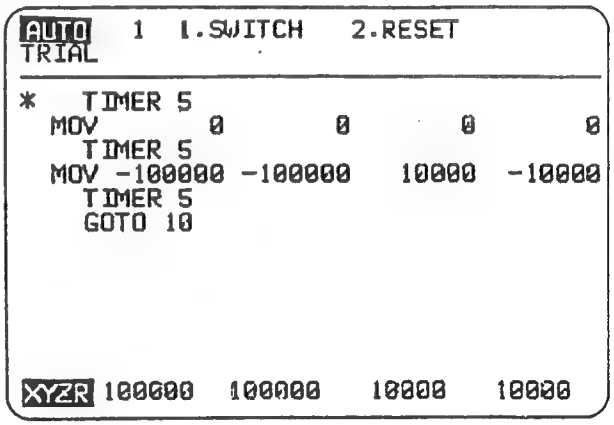
4.5.2.7 PROGRAM RESET PROCEDURES

When you want to interrupt a program while it is running and restart it from the beginning in the Operation Mode, proceed as follows after touching the "STOP" key.

1) Touch [UTL.]:

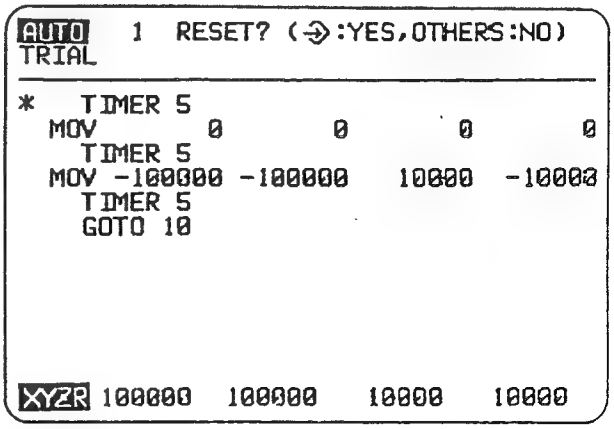
This key actuates utility. A menu appears at the top of the screen.

The "*" mark is displayed at the part way of the program.



2) Touch [2]:

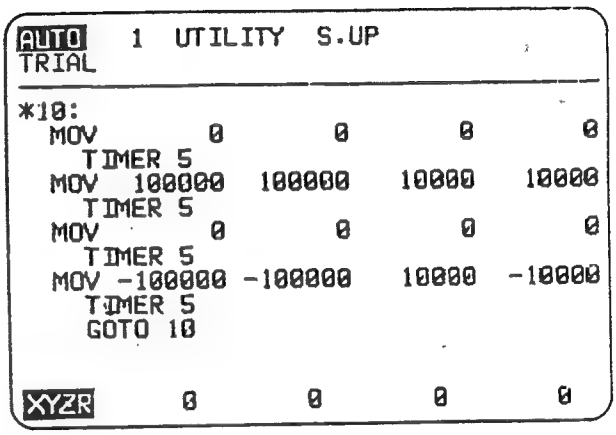
This key resets the program. A confirmation message is displayed on the top of the screen.



3) Touch [→]:

This key performs resetting.

The "*"mark is displayed at the first command line as shown.



4-5-3 SYSTEM MODE

This mode is used for manipulating the whole system. The following four (4) kinds of operations are possible in the System Mode.

1. Changing parameter values.
2. Displaying the program directory.
3. Storing and loading using external memory cassette.
4. Initializing memory, setting initial parameter values, and setting Standard Coordinates.

   In the System Mode except setting Standard Coordinates, the arm operation keys are inoperable and thus the arms cannot be moved.

Touch [SYSTEM]:

This key selects the System Mode.

The System Menu is displayed as shown. The version of the optional 3rd/4th joints (Z/R axes) are also displayed at the top.

```
SYSTEM    SCARA ROBOT  V1.30-0231
          Z:DC.M,R:DC.M 1/50

   1. PARAMETER
   2. DIRECTORY
   3. EXTERNAL MEMORY
   4. INITIALIZE

XYZR      0        0        0        0
```

4-5-3-1 PARAMETER (ALTERING PARAMETER VALUES)

After displaying the System Menu, perform the following:

NOTE:
For details of parameters, refer to Chapter 7 "ROBOT ADJUSTMENT" in this manual.

1) Touch [1]:

This key selects the parameter alteration procedure and the standard parameters are displayed.

There are two (2) types of parameters, standard and option.

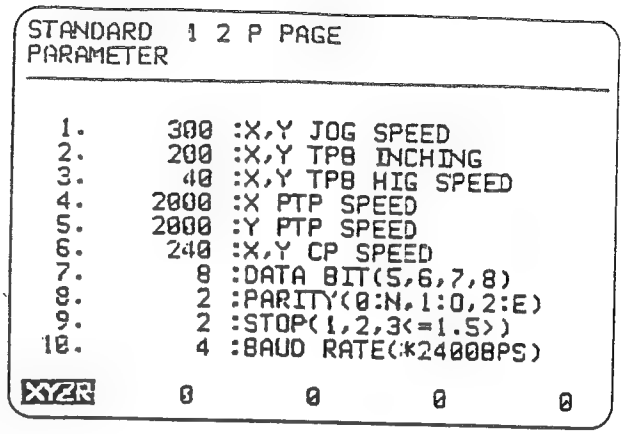
- Standard parameters: These are used for standard specifications.
- Option parameters: These are used for optional specifications.

```
STANDARD  1 2 P PAGE
PARAMETER

 1.     300 :X,Y JOG SPEED
 2.     200 :X,Y TPB INCHING
 3.      40 :X,Y TPB HIG SPEED
 4.    2000 :X PTP SPEED
 5.    2000 :Y PTP SPEED
 6.     240 :X,Y CP SPEED
 7.       8 :DATA BIT(5,6,7,8)
 8.       2 :PARITY(0:N,1:O,2:E)
 9.       2 :STOP(1,2,3(=1.5))
10.       4 :BAUD RATE(*2400BPS)

XYZR      0        0        0        0
```

2) Touch [1]:

This key selects the standard parameter alteration procedure.

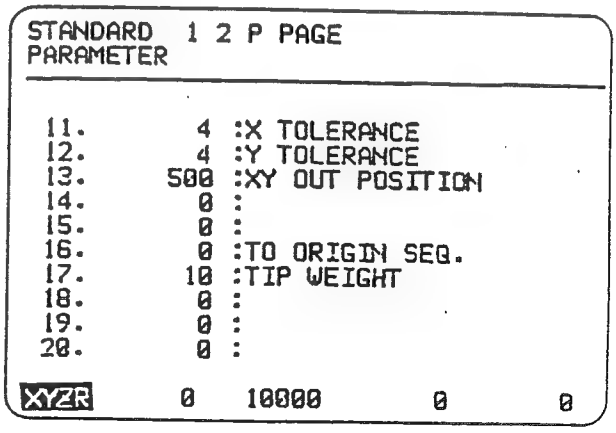
The screen displays from the parameter 1 to parameter 10 in one page unit.



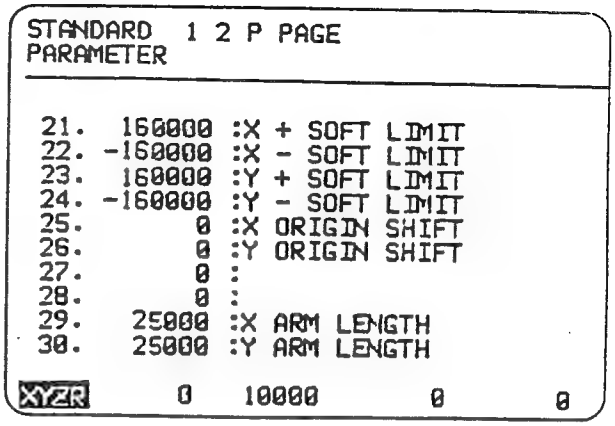
3) Touch [PAGE]:

This key scrolls the screen to next page in one page unit.

The screen displays the parameter 11 to parameter 20 in one page unit.



The screen displays the parameter 21 to parameter 30 in one page unit.

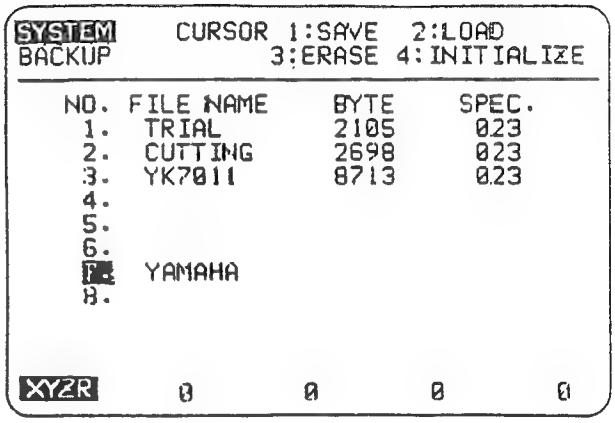


NOTE:

- **There are 30 standard parameters in total.**
- **The displayed standard parameter values show the initial values.**

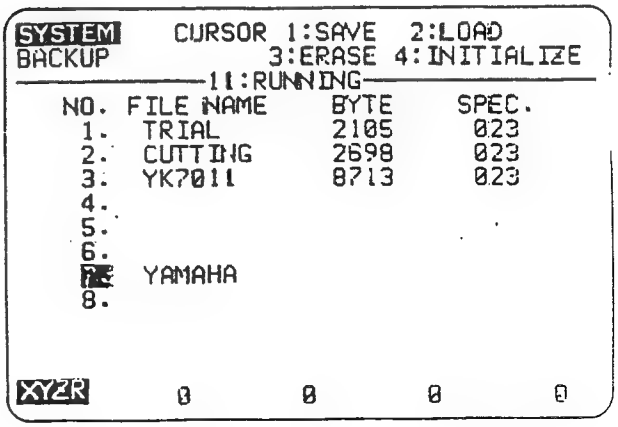
4) Touch [⇨] :

This key completes entry of the file name.



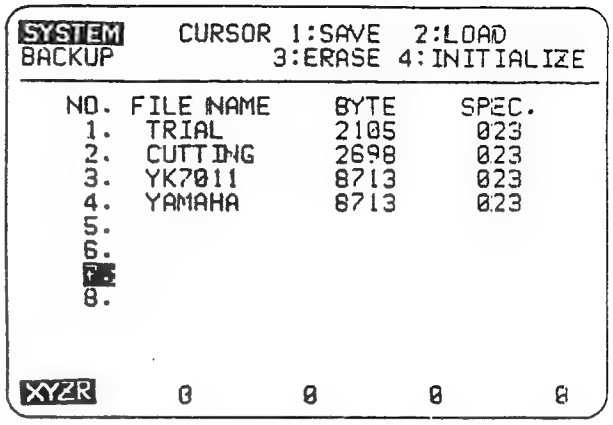
5) Touch [1] :

This key starts the copy of the current controller's data into the memory cassette. The "RUNNING" message is displayed on the screen while copying.



When the data copy is completed, the "RUNNING" message disappears and the new data is stored into the file next to the existing data file automatically.

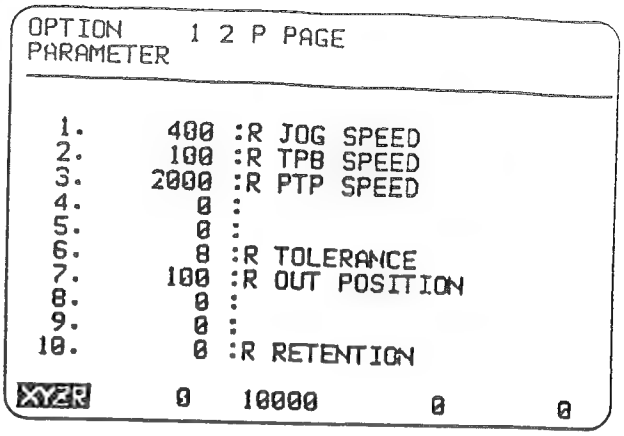
This screen shows that the new data is stored into the file No.4 from the file No.7 automatically.



4) Touch [2]:

This selects the option parameter alteration procedure.

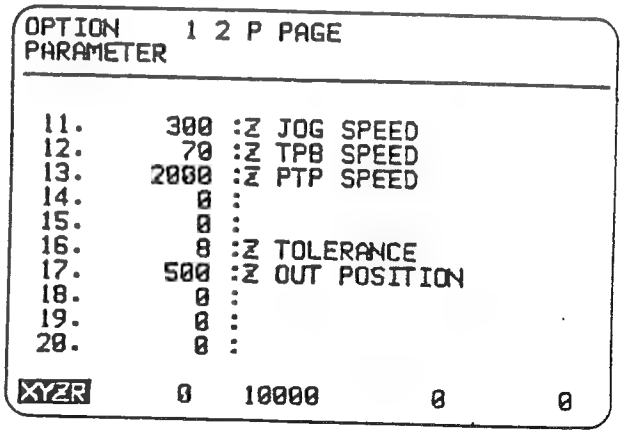
The screen displays from the parameter 1 to parameter 10 in one page unit.



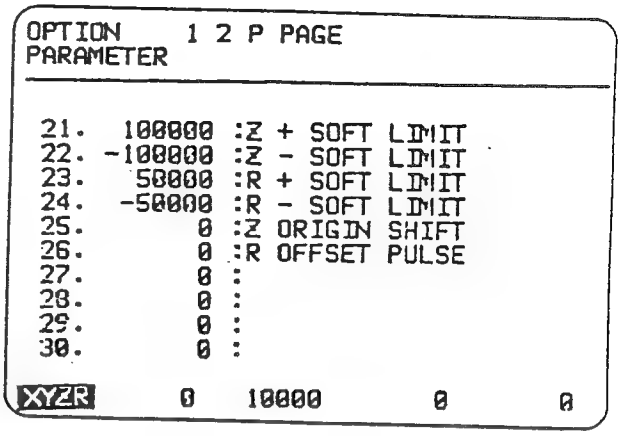
5) Touch [PAGE]:

This key scrolls the screen to next page in one page unit.

The screen displays from the parameter 11 to parameter 20 in one page unit.



The screen displays from the parameter 21 to parameter 30 in one page unit.



NOTE:

- **There are 30 option parameters in total.**
- **The displayed option parameter values show the initial values.**

6) By using the above 1) ~ 5) keys, display the parameter you want to alter.

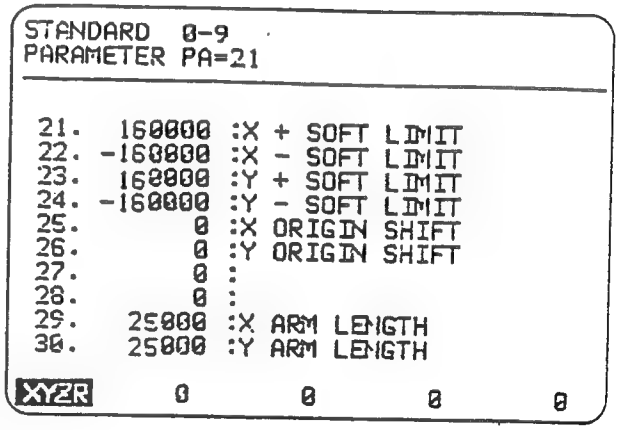
The "PAGE+" key displays the next page.

The "PAGE−" key displays the preceding page.

7) Touch [P]:

This key starts the parameter alteration procedure. The cursor is displayed, prompting parameter number input.

The number of the top line ("21"") appears at the cursor.



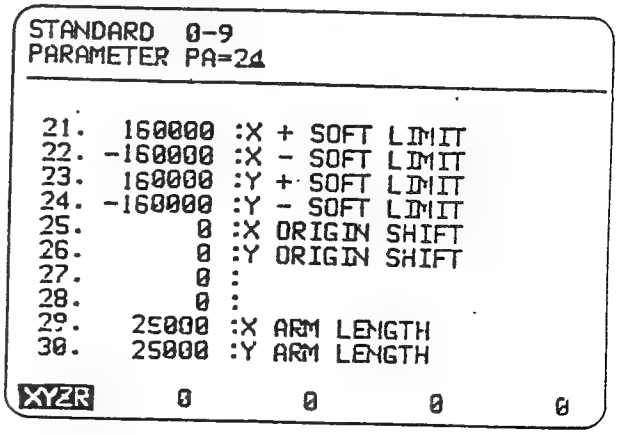
8) Touch [0] ~ [9]:

(parameter numbers 0 ~ 30):

These keys specify the parameter number you want to alter.

The range of numbers displayed on the screen is inputted.

The screen shows inputting "24" within the "21 ~ 30."

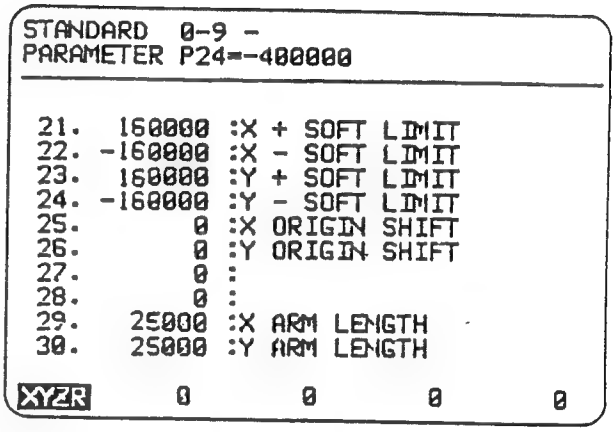


9) Touch [→]:

This key completes the parameter number entry.

The parameter value of the specified number is displayed.

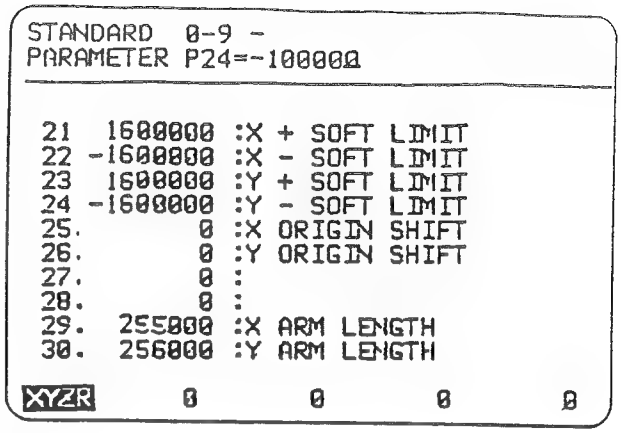
The screen shows the value ("−160000") of the standard parameter "24."



10) Touch [+], [−], [0] ~ [9]:

These keys input the parameter value.

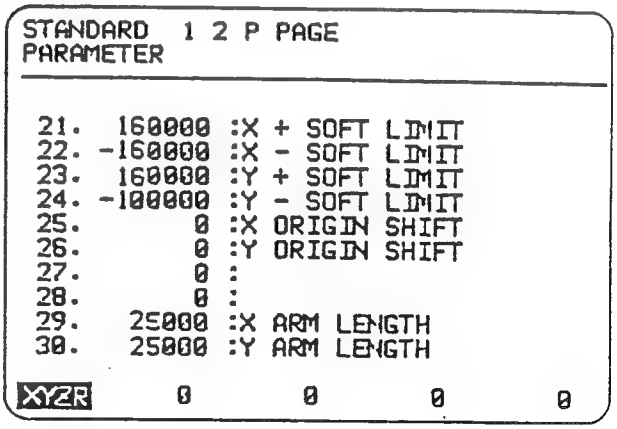
The screen shows the altering the parameter value from −160000 to −100000.



11) Touch [⇨]:

This key completes the parameter value input.

The parameter value are altered to the inputted value ("−100000") in the line of parameter "24" as shown.



– MEMO –

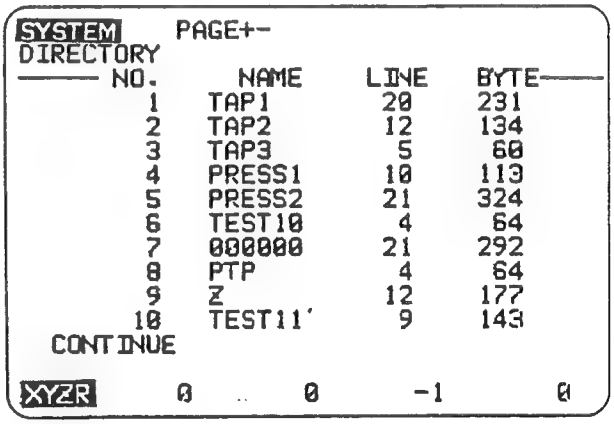
4.5.3.2 DIRECTORY (DISPLAYING THE PROGRAM DIRECTORY)

If you want to check the currently inputted program names, perform the following steps after displaying the System Menu. For the System Menu displaying, refer to 4-5-3 "SYSTEM MODE."

1) Touch [2]:

This key displays the program directory.

The program number, name, number of line, and number of used bytes are displayed for each program currently stored.

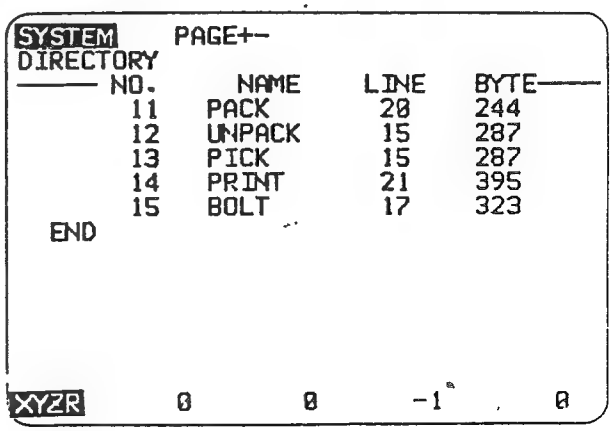


2) Touch [PAGE+] or [PAGE-]:

This key displays the program directory in page unit.

The "PAGE+" key displays the next page as shown.

The "PAGE−" key displays the preceding page.



4.5.3.3 EXTERNAL MEMORY (STORING AND LOADING BY USE OF EXTERNAL CASSETTE)

Refer to Chapter 8 "OPTIONS" in this manual.

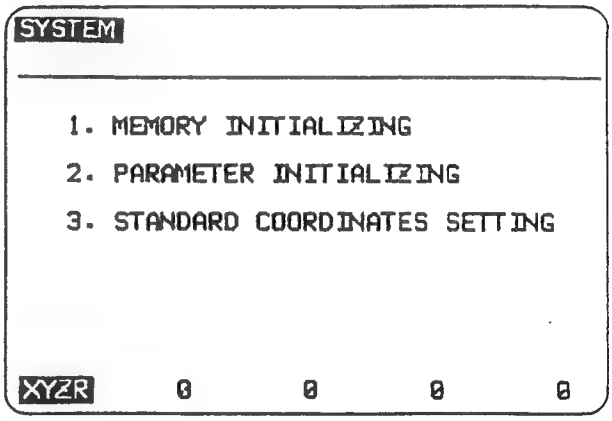
4.5.3.4 INITIALIZE (INITIALIZING OF MEMORY, INITIAL SETTING OF PARAMETER VALUES, AND SETTING OF STANDARD COORDINATES)

If you want to erase the entire memory contents (programs and point data) or to set the parameter values for the initial values, perform the following steps after displaying the System Menu. For the System Menu displaying, refer to 4-5-3 "SYSTEM MODE."

1) Touch [4]:

This key selects the initializing procedure.

The initializing menu is displayed.

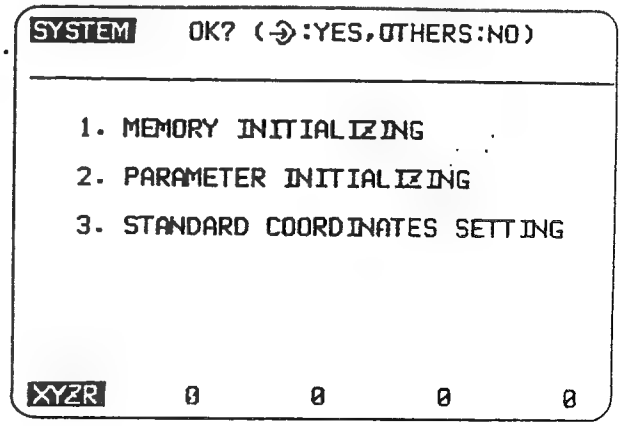


2) Touch [1] and [⇨]:

This key initializes the memory.

All programs and point data are thereby erased.
(Program name "000000" remains.)

When the "⇨" key is touched, initializing is performed (confirmation process).

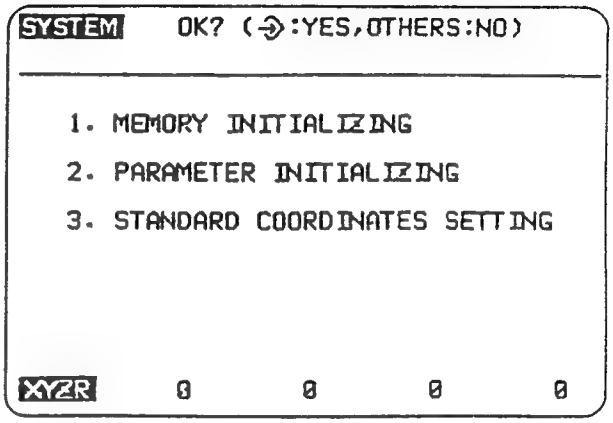


And/or touch [2] and [⇨]:

These keys set the parameters for their initial values.

When the "⇨" key is touched, the setting is performed (confirmation process).

For parameter initial values, refer to Chapter 7 "ROBOT ADJUSTMENT."

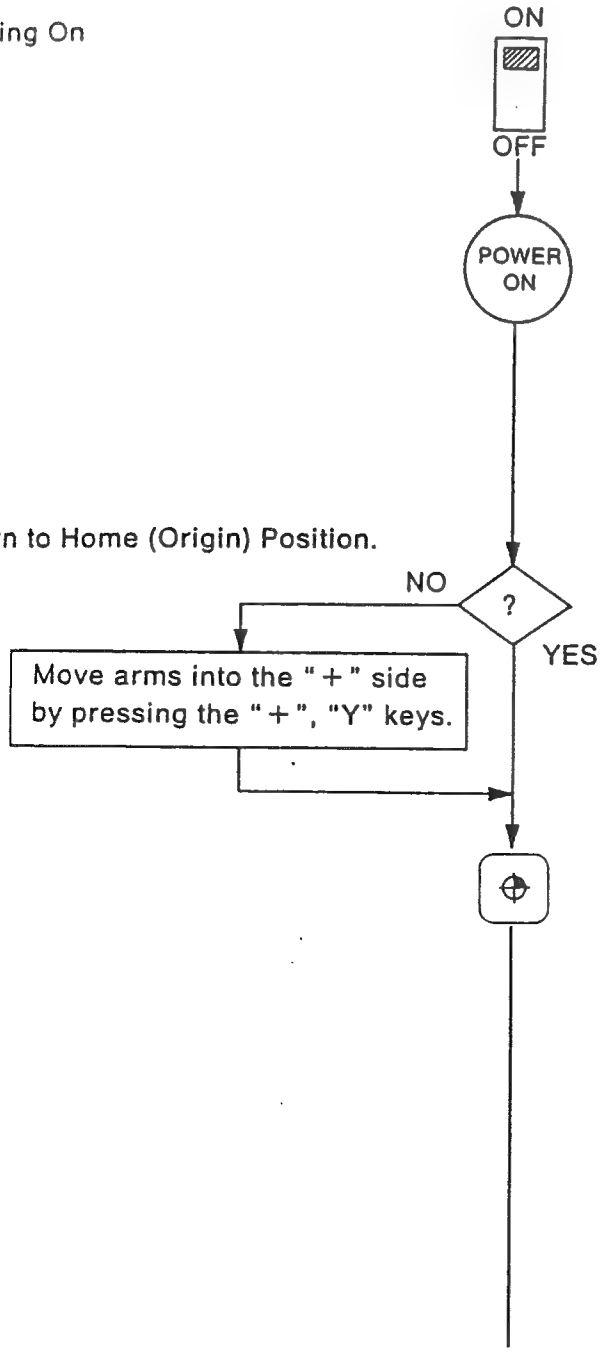


NOTE:
For Standard Coordinates Setting, refer to 5-4.

4.6 GENERAL OPERATION FLOW CHART

A flowchart is provided below to explain how to operate the Robot.

1) Turning On



Turn on overload breaker.

Turn on power switch:

- Robot will be set to Manual Mode and Joint Coordinates.

2) Return to Home (Origin) Position.

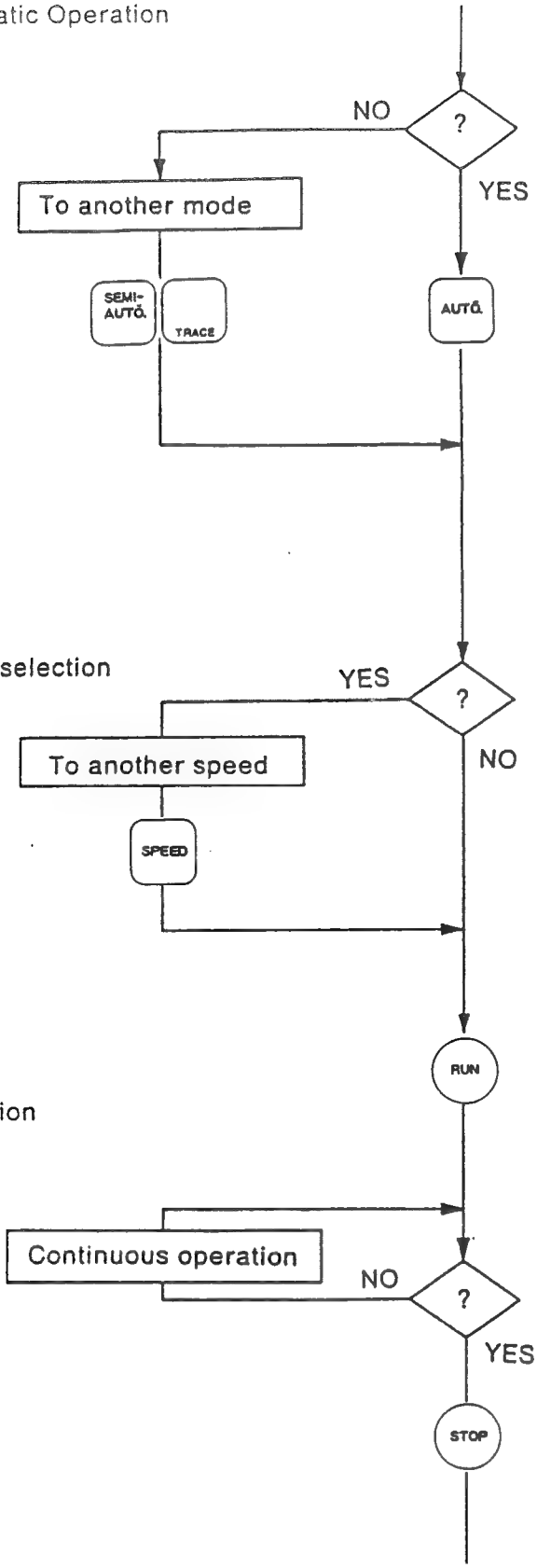
Are 1st and 2nd arms on the "+" side of the Home (Origin) Position?

Touch the " ⊕ " key:

- 1st and 2nd arms move in the "−" direction and stop at the Home (Origin) Position.
- "ORIGIN INCOMPLETE" disappears from the screen.

CONTINUE

3) Automatic Operation



Want automatic operation?

- Touch the "AUTO" key.
- Program last used before this procedure is displayed on screen.
- "*" is displayed for step to be carried out first.
- Speed is set to high speed.

4) Speed selection

Want to change speed?

5) Operation

Touch the "RUN" key:

- Operation starts from step marked "*".

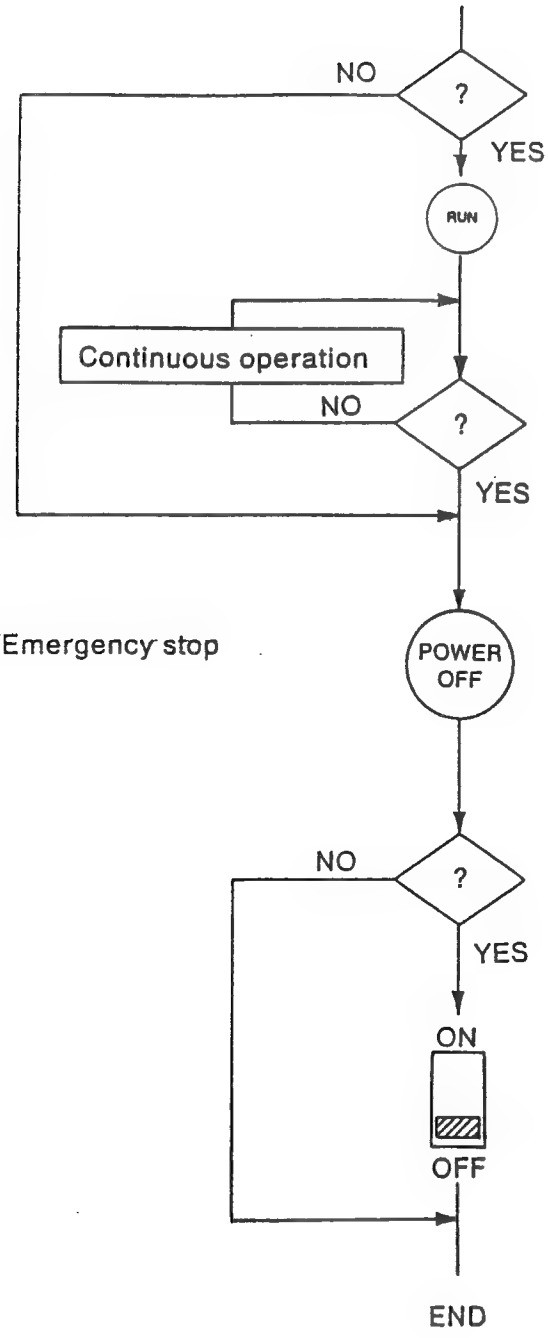
Want to stop?

Touch the "STOP" Key:

- Operation stops.
- The "*" mark is displayed for step where program was stopped.

CONTINUE

6) Restarting



Want to restart?

Touch the "RUN" key:

- Operation starts again with step marked "*".

Want to turn off or make emergency stop?

7) Power off/Emergency stop

Push "POWER OFF" switch.

- All power sources are turned off.

Want to stop operation for long period?

Turn off overload breaker.

CHAPTER 5
PROGRAMMING

CHAPTER 5
PROGRAMMING

5-1 DESCRIPTION

This chapter describes how to write and edit programs for the Robot in the Maker Robot Language.

NOTE:
The Yamaha Robot Language has been developed for easy programming of the Robot's complicated movements and is an easy programming language similar to BASIC (Beginner's All purpose Symbolic Code). If an operation mistake occurs during programming, an error message appears on the upper screen line. (Refer to "APPENDICES" for the error messages.)

5-2 PROGRAM MODE

PROGRAM MODE is used for writing or amending programs.

This mode causes the tip of the robot arm to move parallel to the X and Y axes of the standard coordinate system, regardless of which coordinate system has been previously selected.

When no standard coordinates have been set, the 1st arm (X-axis) which has returned to the Home (Origin) Position is regarded as the X-axis of the coordinates.

There are 4 kinds of UTILITY in the Program Mode:

1. Switching of programs
2. Renaming of programs
3. Copying of programs
4. Erasing of programs

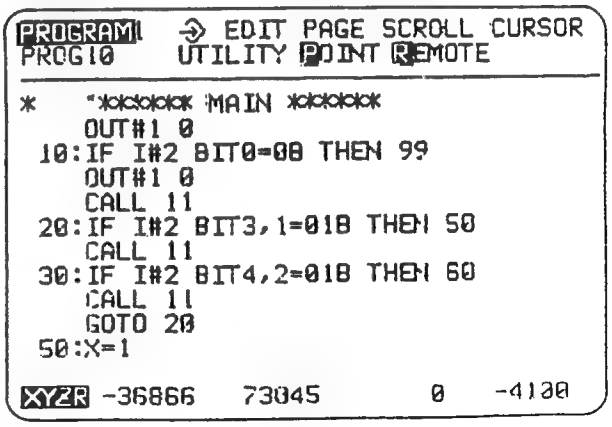
The program is RESET when it is switched or erased or after it has been edited (after touching the "EDIT" key).

After switching on the controller, proceed as follows:

Touch [PROG] :

This key selects the Program Mode for writing and amending programs.

The program currently used is displayed. (In case of a program which has already been executed, the command which is to be executed next is displayed on the first line.)



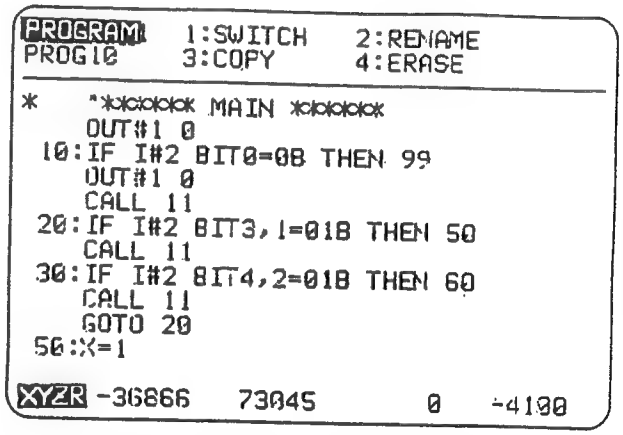
5-2-1 WRITING PROCEDURES

Perform the following procedure to write (create) a new program.

1) Touch [UTL.] :

This key actuates utility.

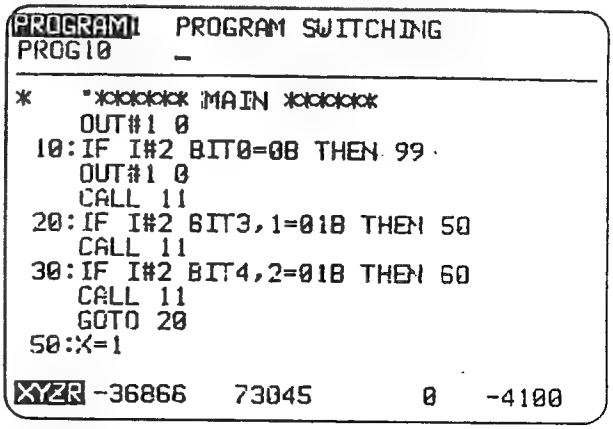
A menu appears at the top of the screen.



2) Touch [1] :

This key selects the a program switching.

The cursor is displayed, prompting entry of the program name.

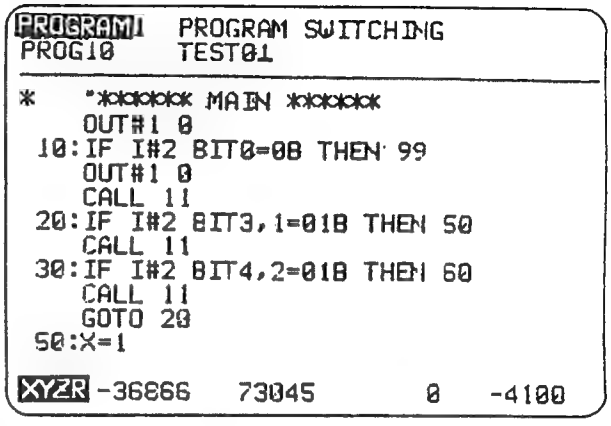


3) Touch [0] ~ [9] and/or [A] ~ [Z]

(for program naming) :

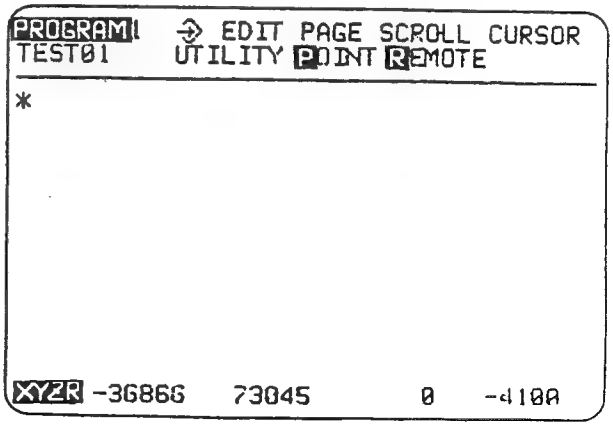
The program name (6 characters or less) is entered. There are no restrictions on the order of the alphanumeric characters.

The screen shows the "TEST01" is entered. The cursor and edit keys are also effective.



4) Touch [→] :

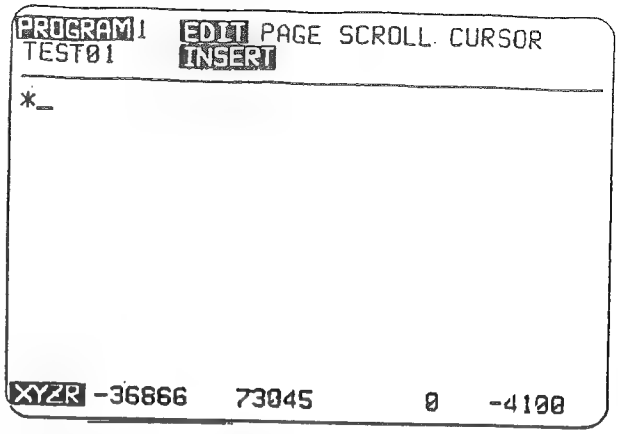
This key completes the entry of the program name.



5) Touch [EDIT] :

This key starts the writing of a program.

For program editing, the cursor is displayed at the extreme left of the "*" line.

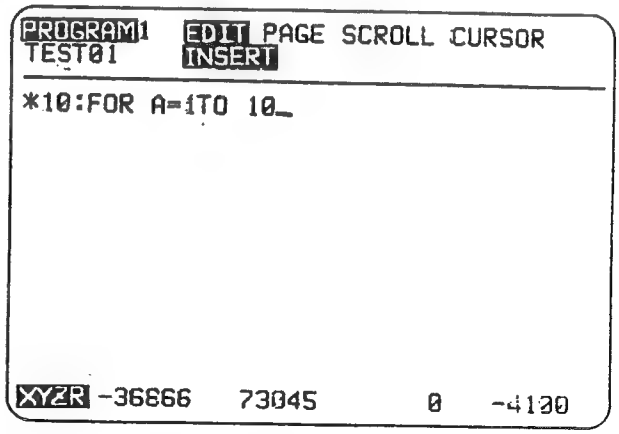


6) **Touch** [0] ~ [9] **and/or** [A] ~ [Z]

(for symbols and instructions):

These keys enter a program.

The cursor and edit keys are also effective.

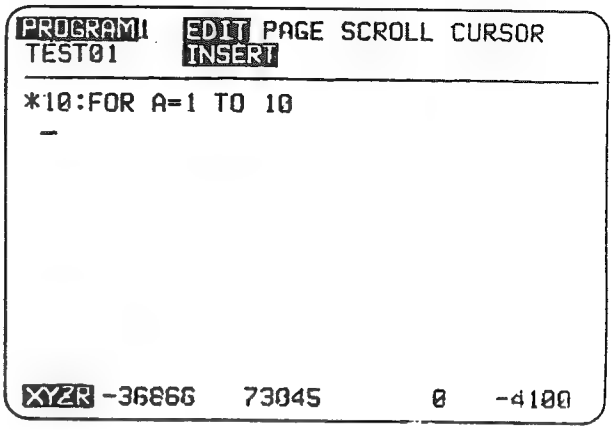


7) **Touch** [→] :

This key completes entry of one program line.

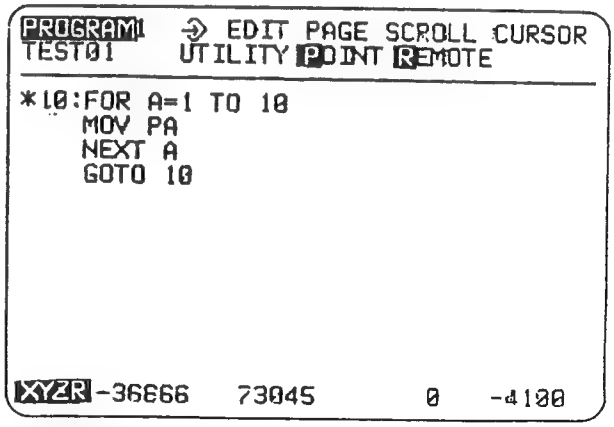
The cursor moves to the next line.

8) **Repeat the above 6) and 7) for writing a program.**



9) **Touch** [EDIT] :

This key completes program editing.
The cursor disappears from the screen.



5-2-2 REWRITING PROCEDURES

The procedure for amending and adding to a program is shown below.

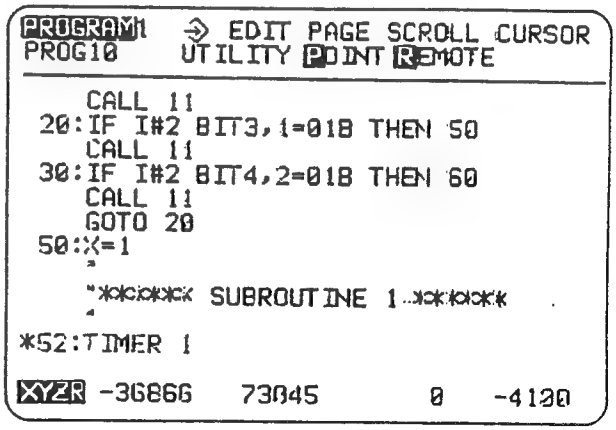
1) **Recall the program you want to rewrite.** Refer to 5-2-1 1), 2), 3), and 4).

2) **Scroll up the program line you want to amend, using the following six keys.**

- **Touch** [↑] **or** [↓] **:**

  These keys move the "*" mark up and down on the screen.

  When the top or bottom of screen is reached, the screen is scrolled down or up.

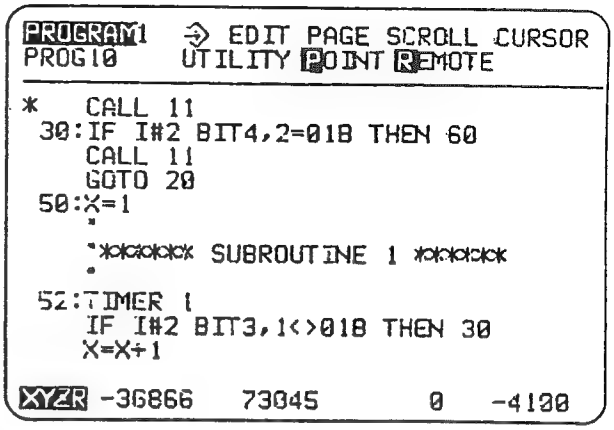


- **Touch** [S.UP] **or** [S.DOWN] **:**

  These keys scroll the program list in line unit.

  S.UP: scrolls up the screen line by line.

  S.DOWN: scrolls down the screen line by line.

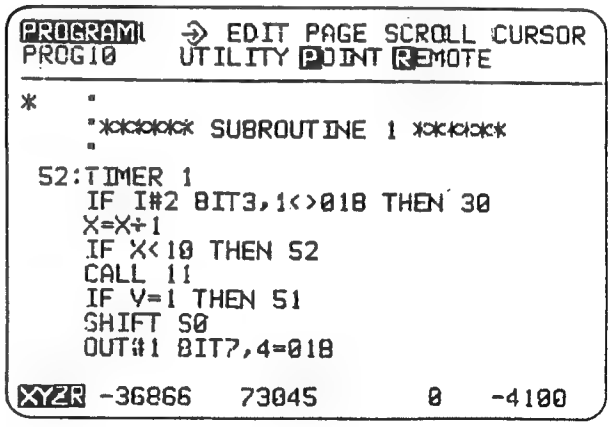


- **Touch** [PAGE+] **or** [PAGE−] **:**

  These keys scroll the program list in screen unit.

  PAGE+: displays the next 11 lines of the list.

  PAGE−: displays the preceding 11 lines of the list.



3) Touch [EDIT] :

The program can be rewritten.

The cursor appears at the extreme left of the "*" marked line.

```
PROGRAM 1  EDIT PAGE SCROLL CURSOR
PROG10
*_   "
     "****** SUBROUTINE 1 ******
     "
 52:TIMER 1
    IF I#2 BIT3,1<>01B THEN 30
    X=X+1
    IF X<10 THEN 52
    CALL 11
    IF V=1 THEN 51
    SHIFT S0
    OUT#1 BIT7,4=01B

XYZR -36866    73045        0    -4100
```

4) Touch [↑], [↓], [←] or [→]:

These keys move the cursor to the word you want to rewrite.

If the cursor is moved downward below the last line by touching the "↓" key, the Insert Mode is automatically selected.

```
PROGRAM 1  EDIT PAGE SCROLL CURSOR
PROG10
*    "
     "****** SUBROUTINE 1 ******
     "
 52:TIMER 1
    IF I#2 BIT3,1<>01B THEN 30
    X=X+1
    IF X<10 THEN 52
    CALL 11
    IF V=1 THEN 51
    SHIFT S0
    OUT#1 BIT7,4=01B

XYZR -36866    73045        0    -4100
```

- **When you want to insert one line:**

  Touch [LINE INS.] :

  This key switches to the Insert Mode.

  In the Insert Mode, any number of new lines (within the memory area) can be inserted wherever desired.

  To cancel the Insert Mode, touch the "LINE INS" key again.

```
PROGRAM 1  EDIT PAGE SCROLL CURSOR
PROG10     INSERT
*    "
     "****** SUBROUTINE 1 ******
     "
 52:TIMER 1
    IF I#2 BIT3,1<>01B THEN 30
    X=X+1
-
    IF X<10 THEN 52
    CALL 11
    IF V=1 THEN 51
    SHIFT S0

XYZR -36866    73045        0    -4100
```

- **When you want to delete one line:**

  Touch [LINE DEL.] :

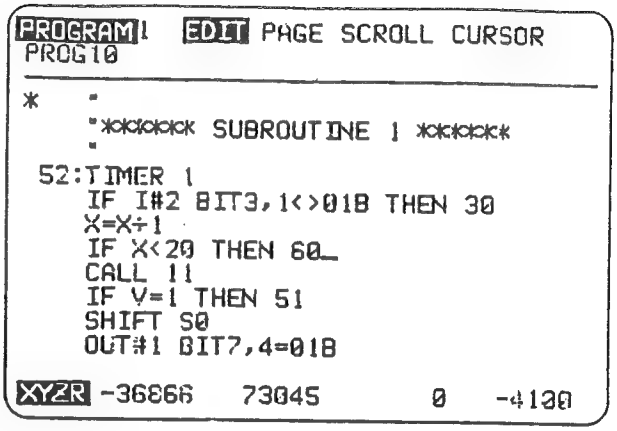
  This key deletes one cursor line.
  The program lines following it are shifted to the upper line.

  The screen shows the construction "IF X<10 THEN 52" is deleted.

```
PROGRAM 1  EDIT PAGE SCROLL CURSOR
PROG10
*    "
     "****** SUBROUTINE 1 ******
     "
 52:TIMER 1
    IF I#2 BIT3,1<>01B THEN 30
    X=X+1
-   CALL 11
    IF V=1 THEN 51
    SHIFT S0
    OUT#1 BIT7,4=01B
    CALL 80

XYZR -36866    73045        0    -4130
```

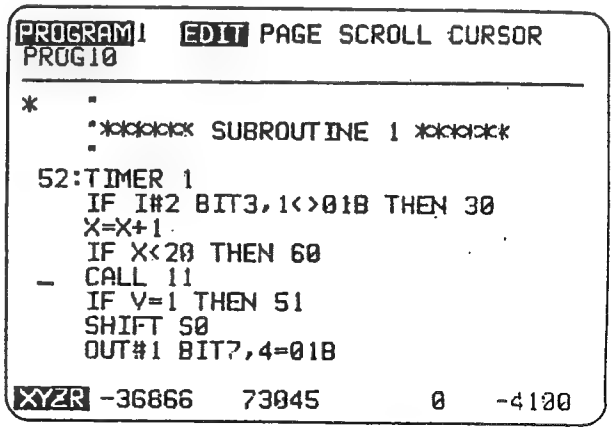
5) Write the construction in the same manner as in 5-2-1 6).

The screen shows the "IF X<10 THEN 52" is rewritten to "IF X<20 THEN 60".



6) Touch  :

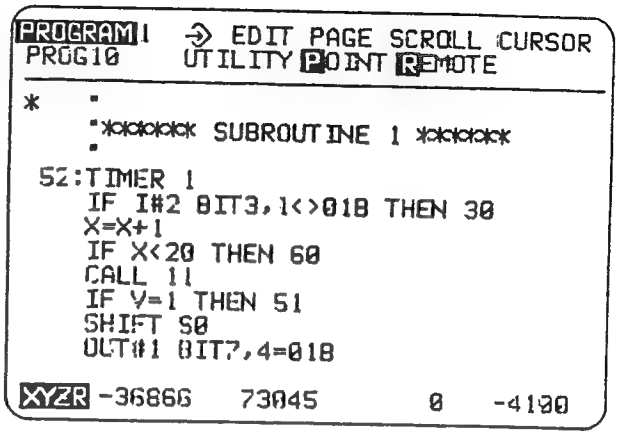
This key completes the entry of one program line.
The cursor moves to the next line.
In the last line, the Insert Mode is automatically selected.



7) Touch  :

This key completes program rewriting.

The cursor disappears from the screen.



5-2-3 RENAMING PROCEDURES

Perform the following steps to rewrite the program already entered.

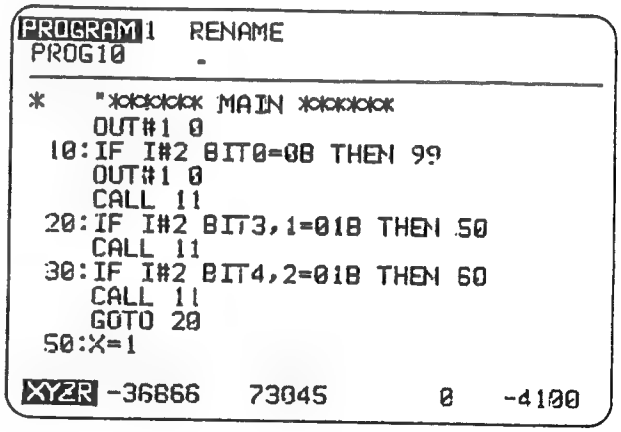
1) Touch [UTL.] :

A menu appears at the top of the screen. Refere to 5-2-1 1).

2) Touch [2] :

This key changes the name of the currently displayed program.

The cursor is displayed, prompting entry of the new program name.

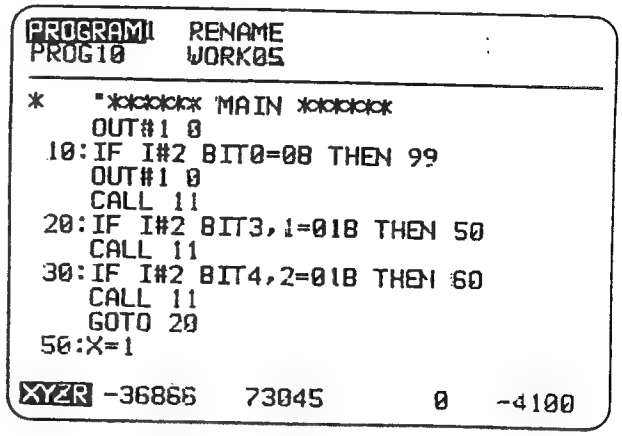


3) Touch [0] ~ [9], [A] ~ [Z]

(program name keys) :

Same as in 5-2-1 3). The program name is entered.

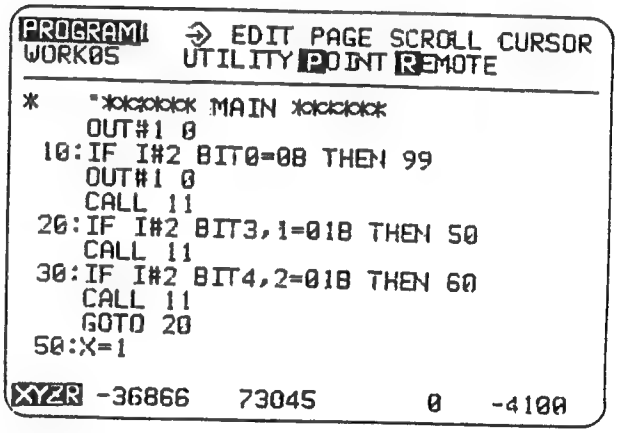
The screen shows the "WORK05" is entered.



4) Touch [→] :

This key completes renaming.

The new program name is displayed on the upper left of the screen.



5-2-4 COPYING PROCEDURES

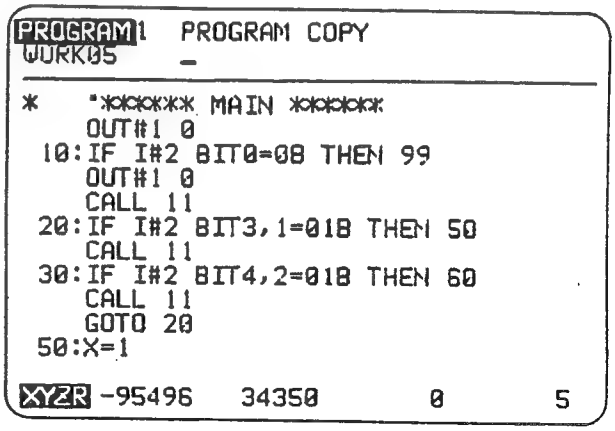
When making a new program similar in construction to one already entered, use a copied one to save time. Copying also protects your program from inadvertent erasure. This section describes such copying procedure.

1) Touch [UTL.] :

A menu appears at the top of the screen. Refer to 5-2-1 1).

2) Touch [3] :

This key copies the currently displayed program under a different name.
The cursor is displayed, prompting entry of the program name.

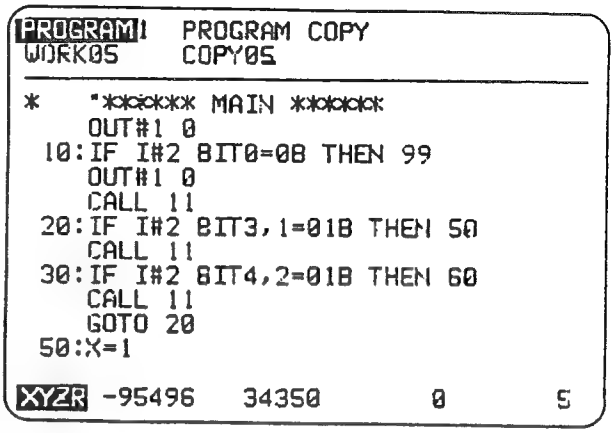


3) Touch [0] ~ [9], [A] ~ [Z]

(prgram name keys):

Same as in 5-2-1 3). The program name is entered.

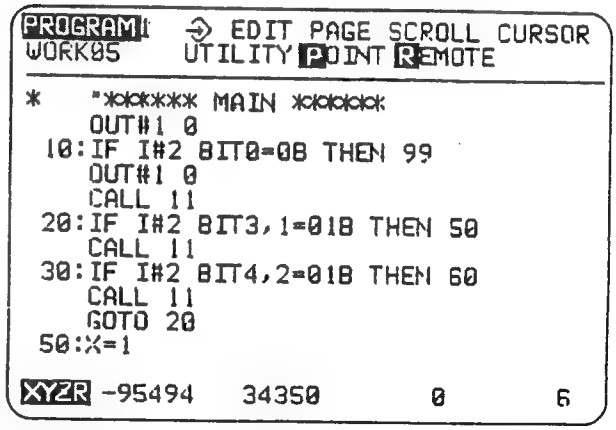
The screen shows the "COPY05" is entered.



4) Touch [→] :

This key completes the copying of a program.

If a specified name is already in use, an error occurs.

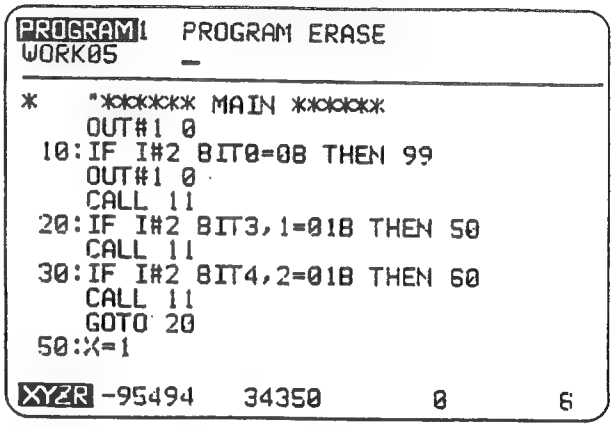


5-2-5 ERACING PROCEDURES

For memory saving and program control efficiency, you are recommended to erase the entered progrms that will no longer be used.

1) Touch [UTL.] :

A menu appears at the top of the screen. Refer to 5-2-1 1).



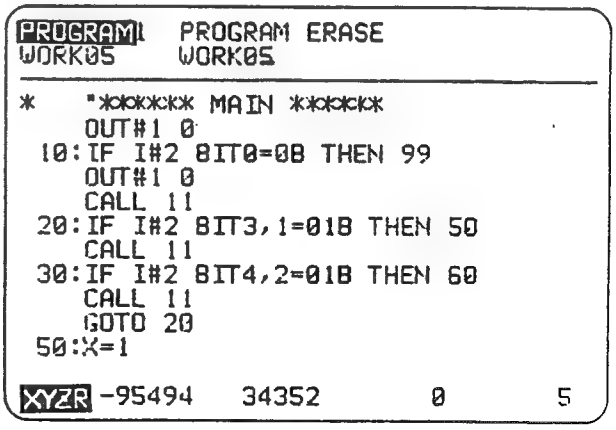
2) Touch [4] :

This key erases any stored program. The cursor is displayed, prompting entry of the program name.

3) Touch [0] ~ [9], [A] ~ [Z]

(program name keys):

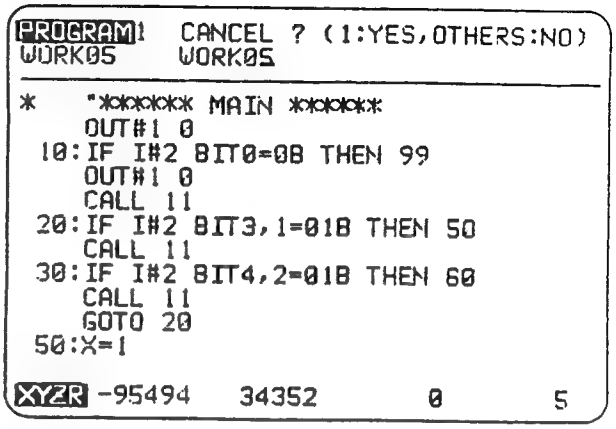
Same as in 5-2-1 3).
The program name you want to erase is entered.



4) Touch [→] :

This key completes the entry of a program name.

A confirmation message is displayed on the top of the screen.



5) Touch [1] :

This key completes the erasing of the program, After completing, the program "000000" will be automatically selected.

If you want to cancel this process, touch any key other than "1".

5-2-6 POINT DATA TEACHING IN PROGRAM MODE

Point data are just like addresses to which the Robot go. Thus, there must be such addresses (point data) for the Robot's movement.

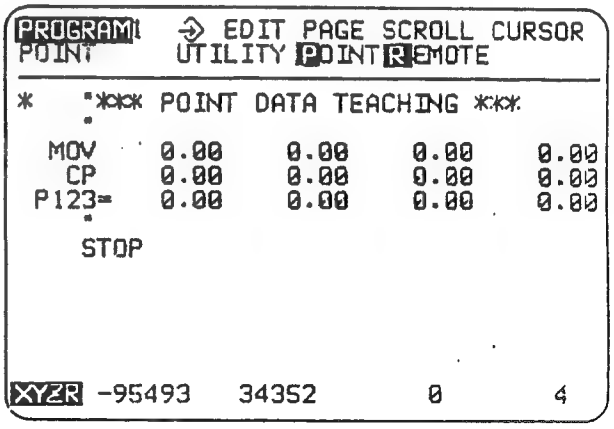
Point data can be stored in Program or Point Data Mode.
This section explains the point data teaching in Program Mode.
For the point data inputting in Point Data Mode, refer to 5-3 "POINT DATA MODE."

1) **First write the construction for entering point data.** The construction format comes in the following three:

   a. MOV n.nn n.nn n.nn

   b. CP n.nn n.nn n.nn

   c. P123 = n.nn n.nn n.nn



For details of the format, refer to 5-6 "ROBOT LANGUAGE."

The above "n.nn" is a dummy numeral to provide space for inputting point data.

For the construction inputting, refer to 5-2-1 "WRITING PROCEDURES."

After completing the input, switch the mode from EDIT to PROGRAM.

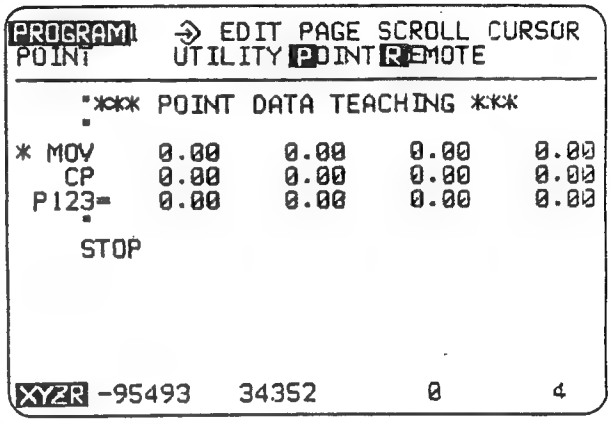
2) **Touch** [↑] **or** [↓] **:**

These keys move the "*" mark to the line on which you want to input point data.

When using the teach pendant:

Touch [STEP UP] **or** [STEP DOWN] **:**

Refer to Chapter 8 "OPTIONS" for the use of the the teach pendant.



5-2-7 OTHER KEYS FUNCTIONS

There are some more important key functions as follows.

5-2-7-1 COORDINATE SYSTEM CHANGING

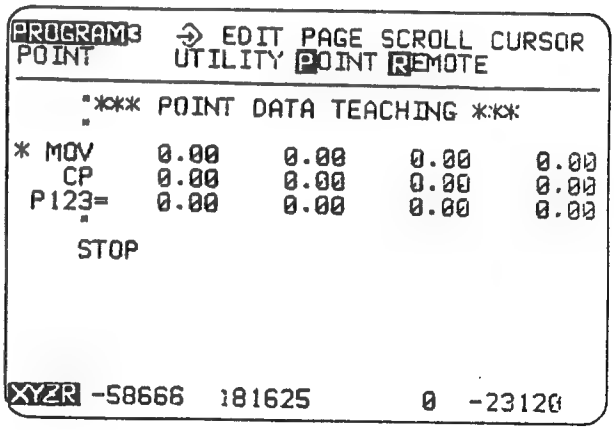
1) Touch [X·Y/θ₁·θ₂] :

This key changes the coordinate system.

Every time this key is touched, the coordinate system changes in the order of joint coordinates → X-Y coordinates → joint coordinates.

The screen shows the joint coordinate system.

Units:
XYZR X [pulse] Y [pulse] Z [pulse] R [pulse]

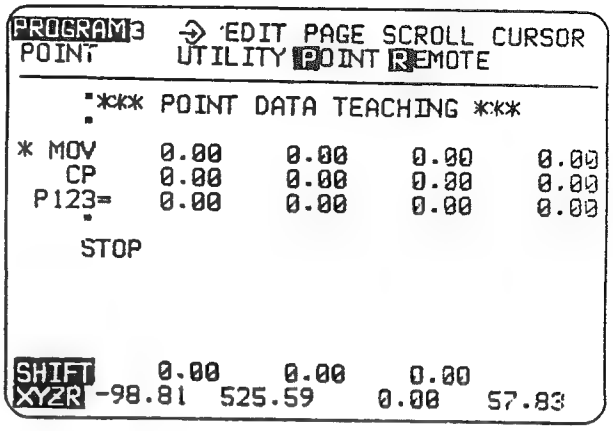


When the X-Y coordinates are selected, the shift date is displayed.

Shift data show the amount of displacement from the standard coordinates to the currently selected shift coordinates.

Units:
SHIFT x [mm] y [mm] θ [deg]
XYZR x [mm] y [mm] z [mm] r [deg]

The current position shows the position in the shift coordinate.

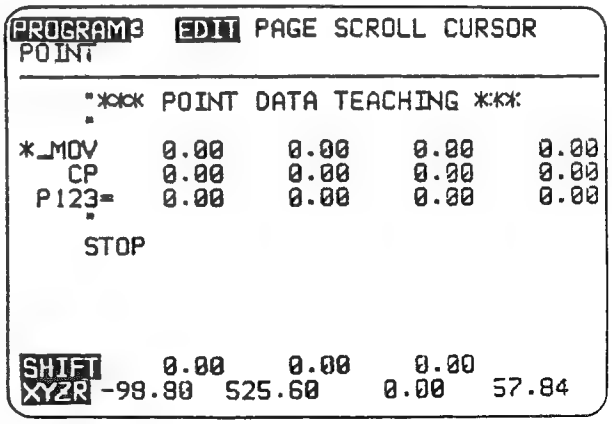


5-2-7-2 ONE LINE STORING

Touch [STORE] :

This key stores the cursor lined data in the line buffer during the program editing.

The screen shows the "MOV 0.00 0.00 0.00 0.00" is stored.



3) Touch [X+], [X−], [Y+], [Y−], [Z+], [Z−], [R+], [R−]:

These keys move the arms to the positions you want to teach the Robot.

If the "SPEED" key is touched simultaneously, high-speed movement is achieved.

When using the teach pendant:

Touch [←], [→], [↑], [↓], [⇑], [⇓], [↻], [↺]:

Use the control keys on the teach pendant to move the arms for point teaching.

If the "~" key is touched simultaneously, high-speed movement is achieved.

NOTE:
Movement is parallel to the coordinate axis of the standard coordinate system.

4) Touch [⇒]:

This key teaches the current point.

When there is a teachable command in the line marked "*", the current position is stored as point data.
After teaching, the "*" work moves to the next line.

NOTE:
Storage form corresponds to the joint coordinate system or the X-Y coordinate system.

```
PROGRAM  ⇒ EDIT PAGE SCROLL CURSOR
POINT    UTILITY POINT REMOTE

    *××× POINT DATA TEACHING ×××
     .
  MOV  -58666   181627        0  -23122
* CP      0.00     0.00     0.00     0.00
 P123=    0.00     0.00     0.00     0.00
     .
    STOP



XYZR -58666   181627        0  -23122
```

Joint Coordinate System

```
PROGRAM  ⇒ EDIT PAGE SCROLL CURSOR
POINT    UTILITY POINT REMOTE

    *××× POINT DATA TEACHING ×××
     .
  MOV  -98.81   525.59     0.00    57.84
* CP      0.00     0.00     0.00     0.00
 P123=    0.00     0.00     0.00     0.00
     .
    STOP



SHIFT    0.00     0.00     0.00
XYZR -98.81   525.59     0.00    57.84
```

X-Y Coordinate System

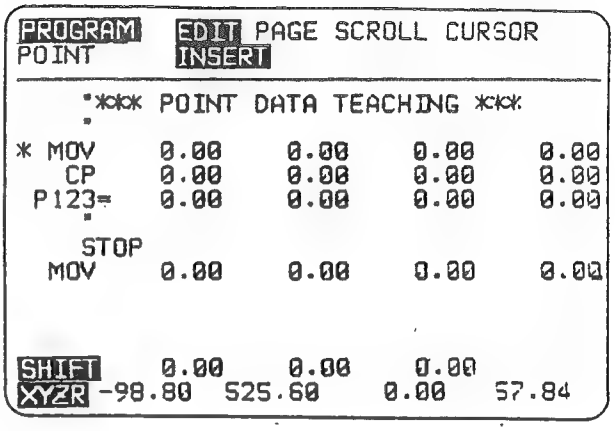
5-2-7-3 ONE LINE RECALLING

Touch [RECALL] :

This key recalls the data stored in the line buffer to the positions following the cursor in the program editing.

The screen shows the "MOV 0.00 0.00 0.00 0.00" is recalled.

Then touch the [RECALL] key for the entry of the recalled one line.



5-2-7-4 ARM SPEED CHANGING

Touch [SPEED] :

This key changes the speed of the arm movement in the point data teaching.
Each touch on this key changes the speed in the order of 3 (low) → 2 (moderate) → 1 (high) → 3.

5-3 POINT DATA MODE

This mode is used for the entry and amendment of point data. Point data can be entered and amended by two methods; teaching the Robot and manually inputting data. The Point Data Mode is selected via the Program Mode. As far as the motional direction of the Robot arm tip is concerned, the Point Data Mode is identical to the Program Mode.

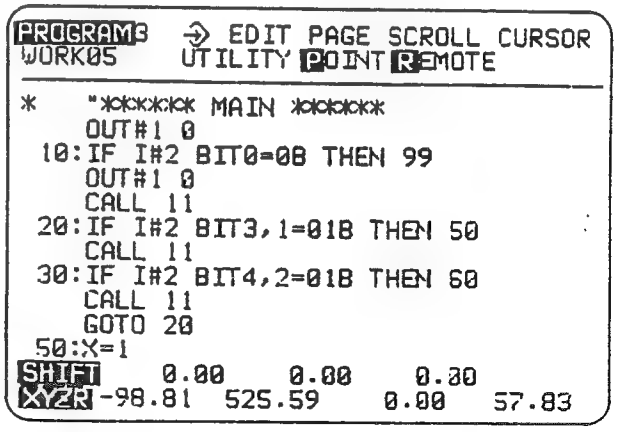
There are two kinds of the Point Data Mode UTILITY:

1. **Point data copying**
2. **Point data erasure**

The following shows how to select point data mode:

1) Touch [PROG] :

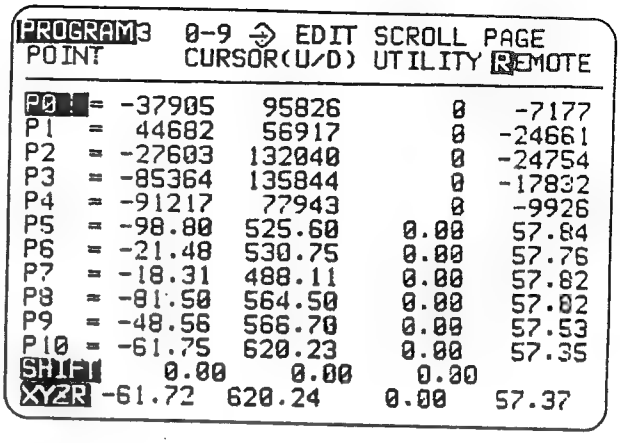
This key selects the Program Mode.



2) Touch [P] :

This key selects the Point Data Mode after the Program Mode.

11 point data are displayed so that the last point used is positioned in the screen center.



5-3-1 POINT NUMBER DISPLAYING PROCEDURES

Before point data input, you have to display on the screen the point number to be inputted.

There are two ways of inputting the point number you want to input.

a. Point number designation

1) Touch [0] ~ [9] (point number keys):

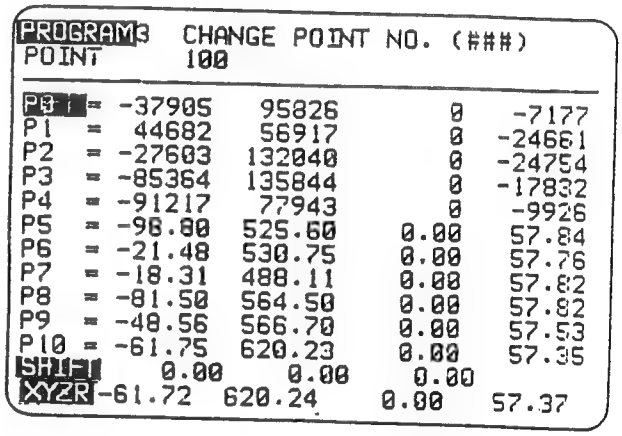
These keys alter the displayed point data.

If any one of the keys "0" ~ "9" is used for input, it is displayed on the upper of the screen.

The number of the point to be displayed on the first line (3 disits or less) is entered.

The cursor and edit keys are also effective.

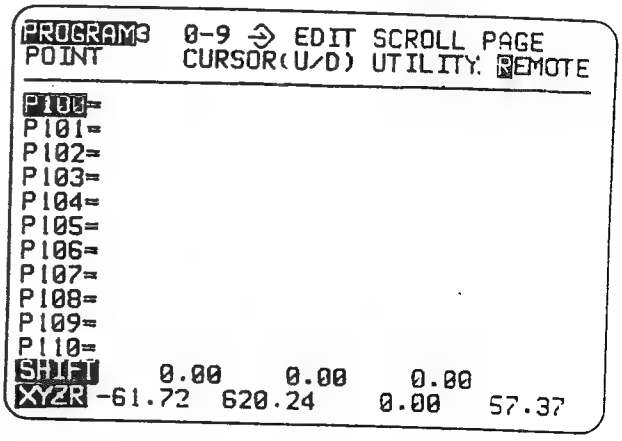
The screen shows the point number "100" is entered.



2) Touch [→] :

This key completes the point number entry.

11 data from the specified number are displayed.



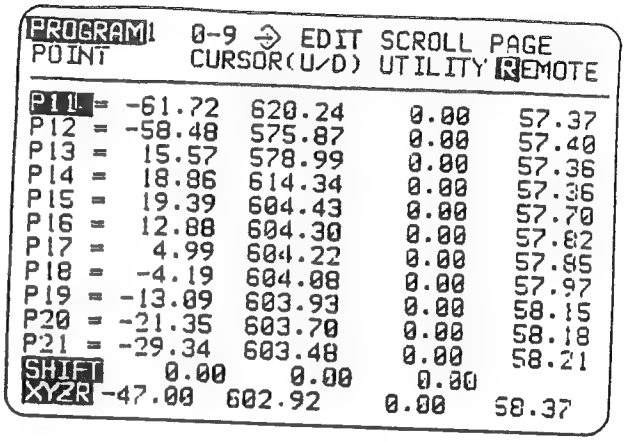
b. Point number scroll

- Touch [PAGE+] or [PAGE−] :

  This key scrolls the point data display in the full screen unit.

  PAGE+: displays the next 11 points.

  PAGE−: displays the preceding 11 points.

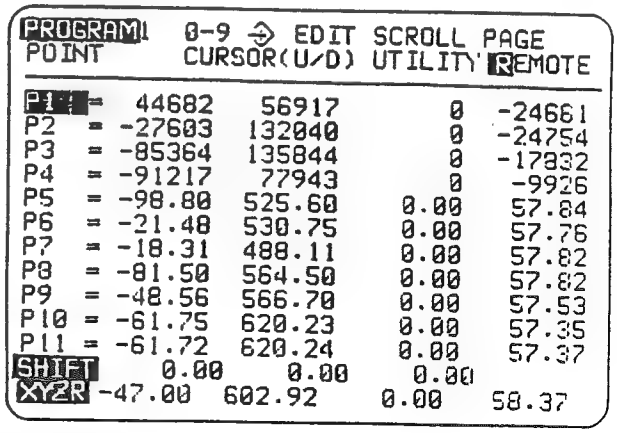


- Touch [S. UP] or [S. DOWN] :

  This key scrolls the point data display in the full line unit.

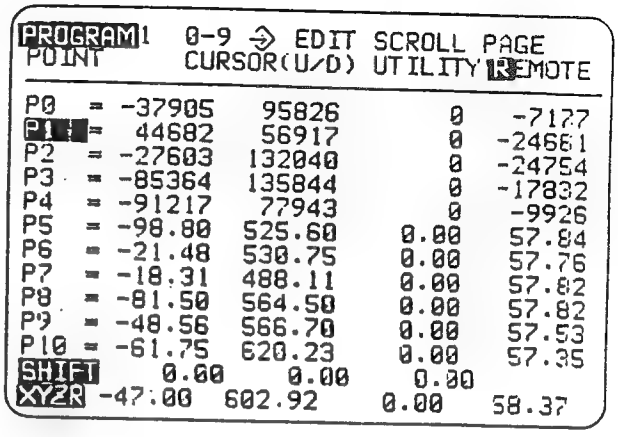
  S. UP : scrolls up by one point. .

  S. DOWN : scrolls down by one point.



- Touch [↑] or [↓] :

  This key moves the reverse video display of the point number up or down. When the top or bottom of the screen is reached, it is scrolled up or down.



- **when using the teach pendant:**

  Touch [STEP UP] or [STEP DOWN] :

  Same as above.

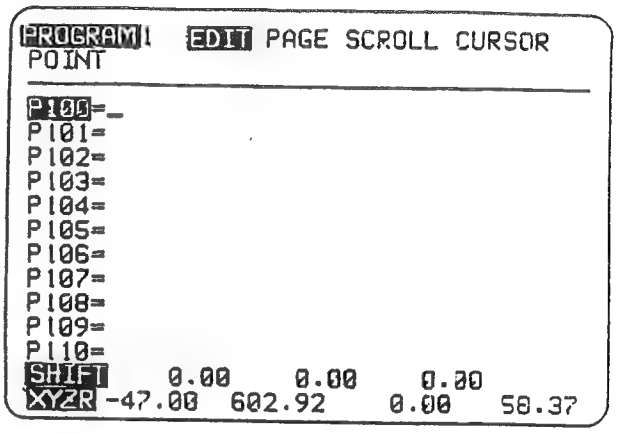
5-3-2 MANUAL POINT DATA INPUTTING PROCEDURES

Prepare the point data by calculation beforehand. Then input the point data manually.
Designate the point number by reference to 5-3-1.
The following explains the input procedure.

1) Touch [EDIT] :

This key begins the point data inputting.

The cursor appears on the left of the point data line which is displayed in reverse video.



2) Touch [0] ~ [9], [.], [+], [-]

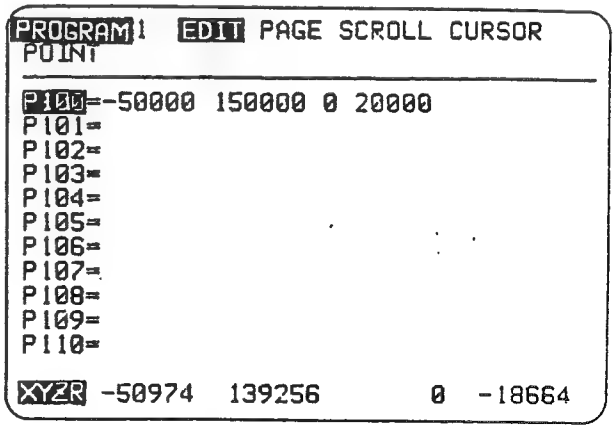
(point data keys):

These keys enter point data.
Data are separated by a space.
Format:

Joint coordinates:

±####### [pulse]

The + mark and preceding zeros can be omitted.

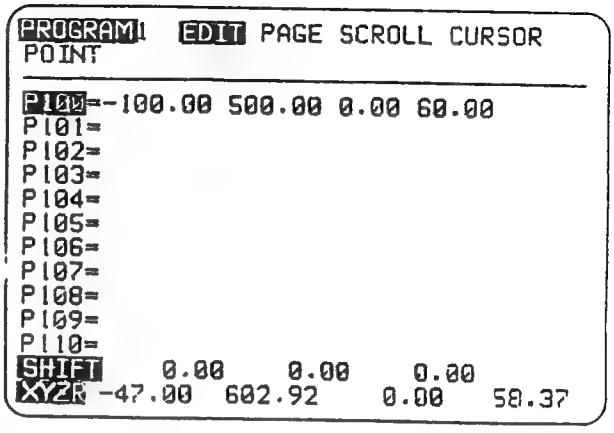


Joint Coordinates

XY coordinates:

±###.## [mm]

The + mark and zeros following the decimal point can be omitted.
The cursor and edit keys are also effective.



X-Y Coordinates

3) Touch [⇨] :

This key completes data entry for one point.
The cursor moves to the next point data line.

4) Touch [EDIT] :

This key completes point data inputting.
The cursor disappears from the screen.

5-3-3 POINT DATA TEACHING IN POINT DATA MODE

Point data can be read directly from the arm position. The value thus read is entered per the designated point number.

After designating the point number as in 5.3.1, proceed to teaching as follows:

1) Touch [X-Y/θ1-θ2] :

This key selects the X-Y coordinate or Joint coordinate (pulse) system. Refer to 5-2-7 1).

2) Touch [X+], [X−], [Y+], [Y−], [Z+], [Z−], [R+], [R−] :

These keys move the arms to the positions you want to teach the Robot.

If the "SPEED" key is touched simultaneously, high-speed movement is achieved.

When using the teach pendant:

Touch [←], [→], [↑], [↓], [⇑], [⇓], [↻], [↺] :

Use the control keys on the teach pendant to move the arms for point teaching.

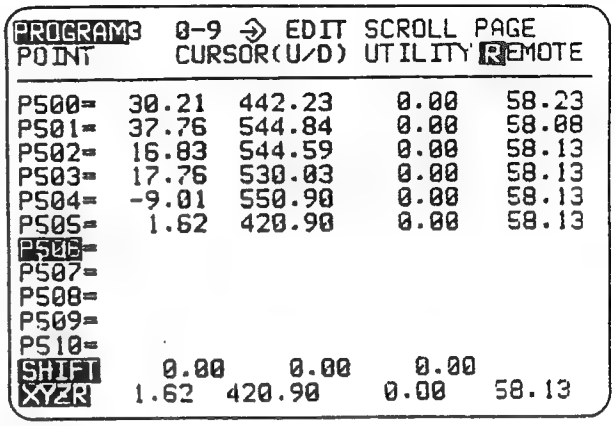
If the "~" key is toched simultaneously, high-speed movement is achieved.

NOTE:
Movement is parallel to the coordinate axis of the standard coordinate system, regardless of the current system of coordinates.

3) Touch [⇒] :

This key teaches current point.

The data of the current position is set in the point displayed in reverse. (Setting is performed conforming to the current co-ordinate system.) The point following is then displayed in reverse.



5-3-4 POINT DATA COPYING

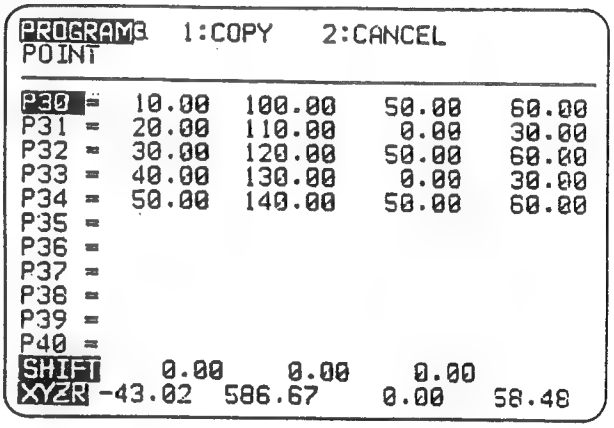
The point data already entered can be copied under a different point number.

Follow the procedure below.

1) Touch [UTL.]:

This key actuates utility.

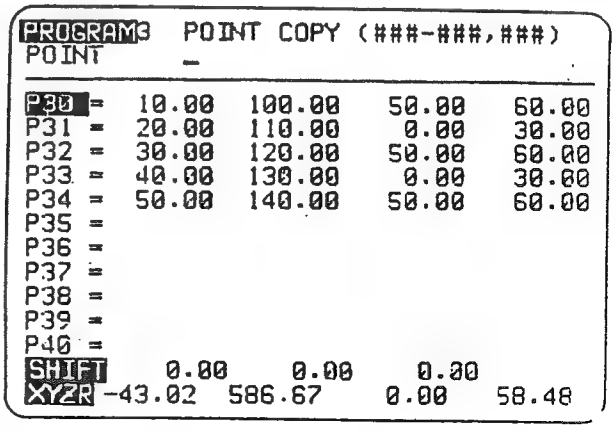
A menu appears at the top of the screen.



2) Touch [1]:

This key selects the point copy.

The "POINT COPY (### −###.###)" message and cursor are displayed on the top of the screen, prompting the input of point numbers.



3) Touch [0] ~ [9], [−], [,]:

These keys enter the copy parameters (point numbers).

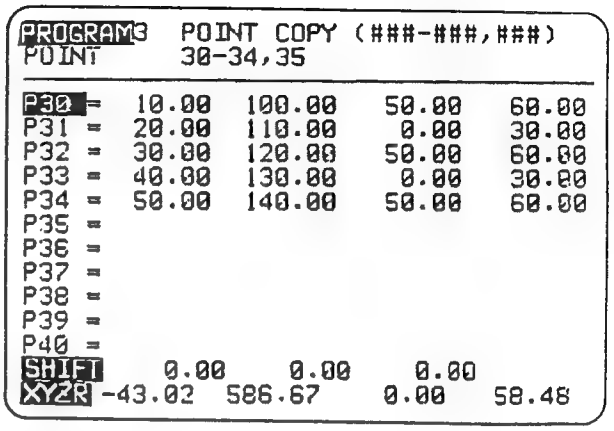
Format:

$$\frac{\#\#\#\#}{\#\#\#\#}_{1} \; - \; \frac{\#\#\#\#}{\#\#\#\#}_{2} \; , \; \frac{\#\#\#\#}{\#\#\#\#}_{3}$$

1. Initial point number of copy range.
2. Point completion number of the copy range.
3. Initial point number of the transfer destination.

The cursor and edit keys are also effective.

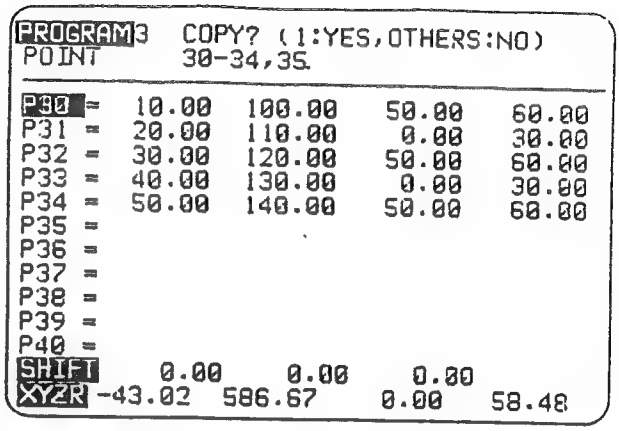
In the example on the right, the data of points 30 to 34 are copied to points 35 to 39.



4) **Touch** [⇨] :

This key performs point data copying.

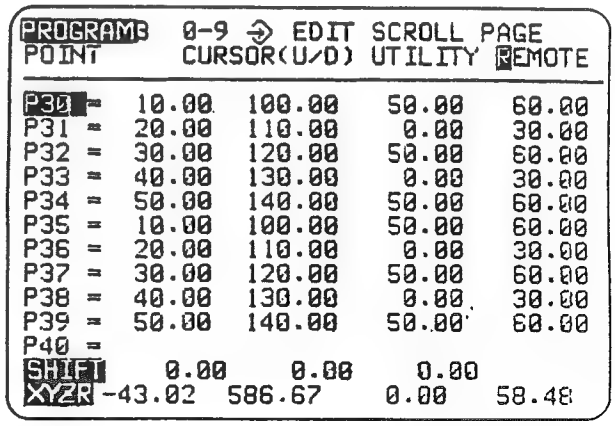
A confirmation message is displayed on the top of the screen.



5) **Touch** [1] :

This key completes point data copy.

If you want to cancel the copying, touch any key other than "1".



5-3-5 POINT DATA CANCELING

For reasons of control (to avoid confusion), you are recommended to erase the point data not in use.

Proceed as follows.

1) Touch [UTL.] : Same as in 5-3-4 1).

2) Touch [2] :

This key selects point data cancelling.

The "POINT CANCEL (### – ###)" message and cursor are displayed on the top of the screen, prompting the input of point numbers.

```
PROGRAM3  POINT CANCEL(###-###)
POINT     _
-------------------------------------
P123= -43.02  586.67    0.00   58.48
P124= -42.06  567.26    0.00   58.64
P125= -53.17  566.91    0.00   58.89
P126= -10.37  569.08    0.00   58.84
P127=  -9.00  581.29    0.00   58.84
P128=  -5.70  536.02    0.00   59.01
P129= -23.43  535.53    0.00   59.21
P130= -75970  180948       0  -20436
P131= -73271  185914       0  -21400
P132= -76856  189862       0  -21428
P133= -75032  189657       0  -21622

XYZR -70099  178075       0  -20902
```

3) Touch [0] ~ [9], [–] :

These keys enter cancelling parameters (point number).

Format:

$$\underset{1}{\#\#\#\#} \; - \; \underset{2}{\#\#\#}$$

1. Cancel commencement point number.
2. Cancel completion point number.

Ex: 123–256: cancels points from point 123 to point 256.

The cursor and edit keys are also effective.

```
PROGRAM3  POINT CANCEL(###-###)
POINT     123-256
-------------------------------------
P123= -43.02  586.67    0.00   58.48
P124= -42.06  567.26    0.00   58.64
P125= -53.17  566.91    0.00   58.89
P126= -10.37  569.08    0.00   58.84
P127=  -9.00  581.29    0.00   58.84
P128=  -5.70  536.02    0.00   59.01
P129= -23.43  535.53    0.00   59.21
P130= -75970  180948       0  -20436
P131= -73271  185914       0  -21400
P132= -76856  189862       0  -21428
P133= -75032  189657       0  -21622

XYZR -70099  178075       0  -20902
```

4) Touch [⇨] :

This key performs point data canceling.

A confirmation message is displayed on the top of the screen.

```
PROGRAM3  CANCEL ? (1:YES,OTHERS:NO)
POINT     123-256_
-------------------------------------
P123= -43.02  586.67    0.00   58.48
P124= -42.06  567.26    0.00   58.64
P125= -53.17  566.91    0.00   58.89
P126= -10.37  569.08    0.00   58.84
P127=  -9.00  581.29    0.00   58.84
P128=  -5.70  536.02    0.00   59.01
P129= -23.43  535.53    0.00   59.21
P130= -75970  180948       0  -20436
P131= -73271  185914       0  -21400
P132= -76856  189862       0  -21428
P133= -75032  189657       0  -21622

XYZR -70099  178075       0  -20902
```

5) Touch [1] :

This key completes point data canceling.

If you want to cancel the point data canceling process, touch any key other than "1".

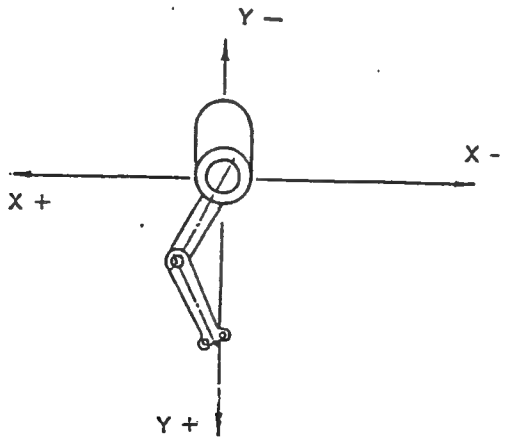
5-4 STANDARD COORDINATES SETTING

5-4-1 DESCRIPTION

Setting the standard coordinates makes available the following useful features, with greater efficiency in programming for the Robot.

- The arm tip makes orthogonal movement on teaching.
- Point data can be inputted manually from a work size.
- Shifting coordinates can be established. (Refer to 5-5 "SHIFT COORDINATES SETTING".)

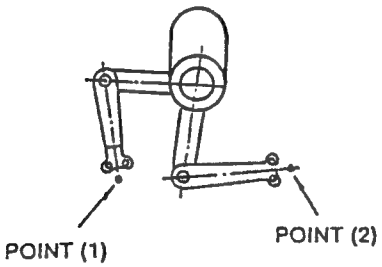
The standard coordinates are pre-set by the factory or distributor at the time of the shipping, as follows.



The standard coordinates can be altered to meet user's working requirements if necessary.

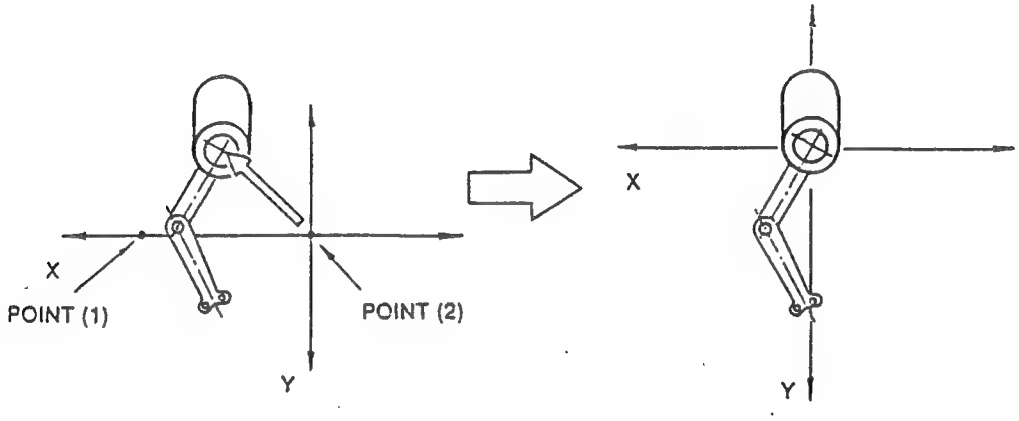
The outline of the standard coordinates setting is as follows. (Refer to 5-4-2 "STANDARD COORDINATES SETTING PROCEDURE" for actual setting).

1) After returning to the Home (Origin) Positioin and selecting the "STANDARD COORDINATES SETTING" in the System Mode, teach two points [Point (1), Point (2)] whose relative positional relationship is known.



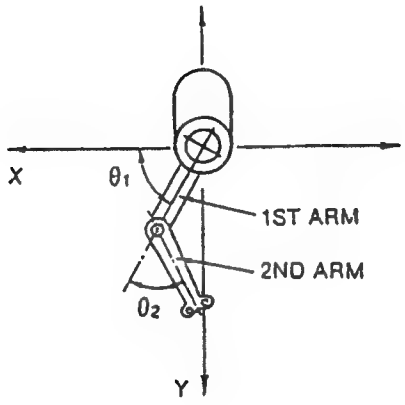
2) The coordinates can be set by inputting the point values of (X1', Y1') and (X2', Y2').

The coordinates resulting from parallel movement of the coordinates (X', Y') up to the center of the Robot shoulder become the standard coordinates (X, Y).



3) The angle θ_1 (pulses) formed by the 1st arm and axis X and the angle θ_2 (pulses) formed by the 2nd and 1st arms are stored during return to the home (origin) position.

When the X-Y coordinates is selected, the microprossesor in the controller converts the joint coordinates (pulses) to the X-Y coordinates by using these offset angles (θ_1 and θ_2).



5-4-2 STANDARD COORDINATES SETTING PROCEDURE

The example of the standard coordinates setting procedure is explained as following.

1) **Install the standard coordinates setting tools.**

YAMAHA recommends the following illustrated samples as the setting tools.
When you manufacture the setting tools, refer to Chapter 10 "SPECIFICATION".

NOTE:
The standard coordinates setting tools, shown as below, are available as an option.

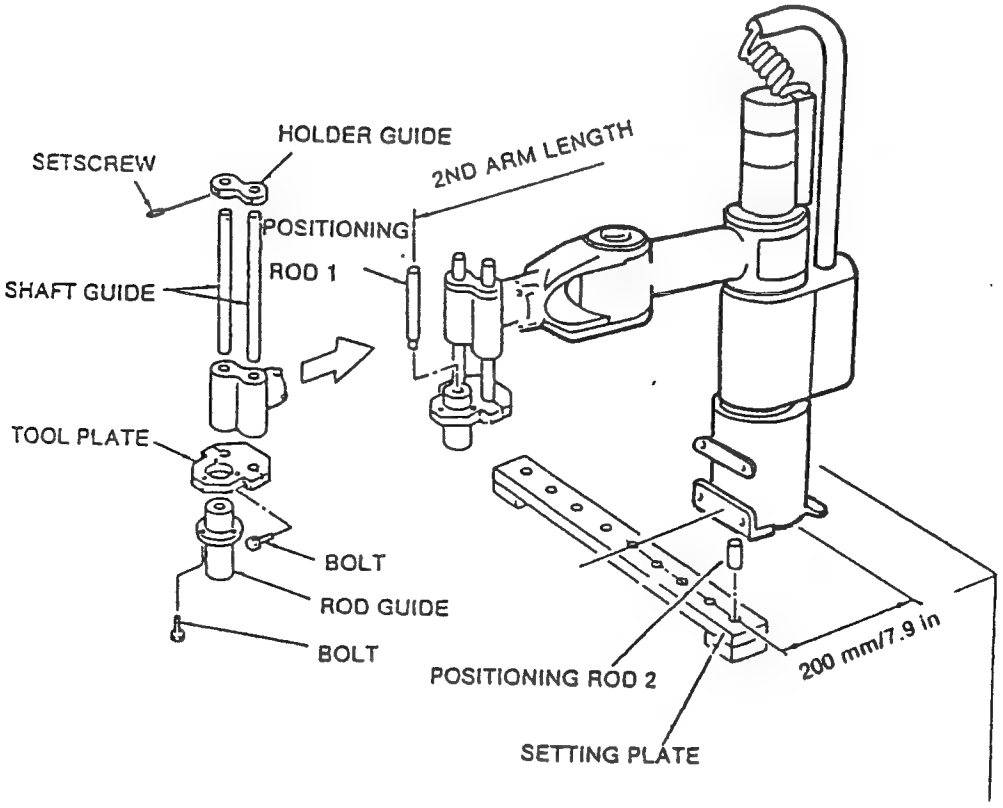


FIG. 5-1 Standard Coordinates Setting Tools

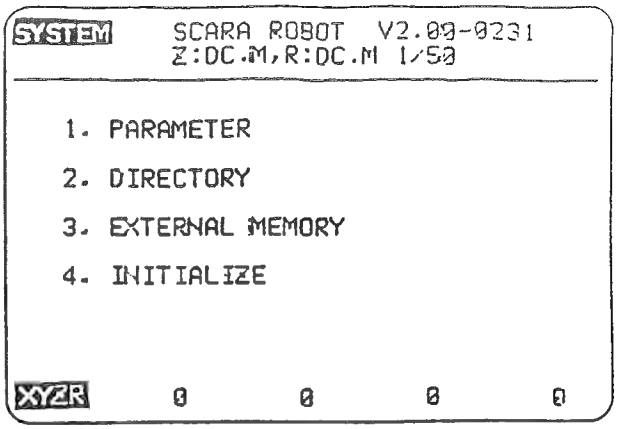
2) **Set the standard parameter No.30 (2nd arm length) accurately.**

For details of the parameter setting, refer to 4-5-3-1 "PARAMETER" in Chapter 4.

3) Touch [SYSTEM] :

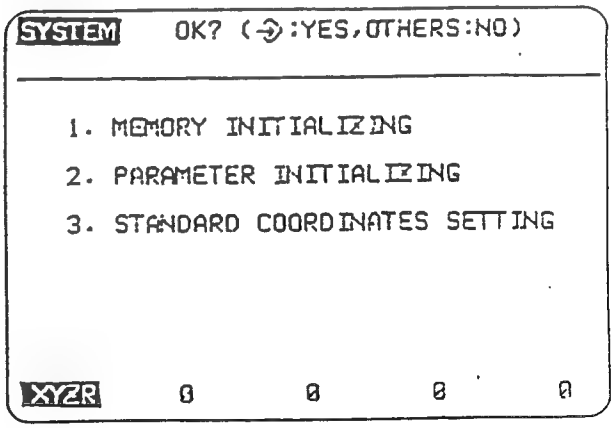
This key selects System Mode.

The screen shows the system menu.



4) Touch [4] :

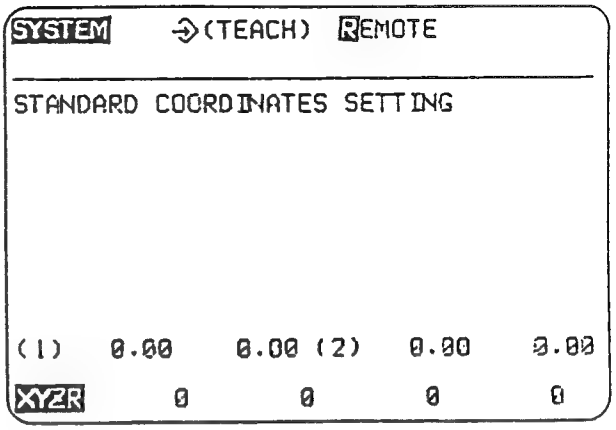
This key selects INITIALIZING.



5) Touch [3] :

This key begins the STANDARD COORDINATES SETTING.

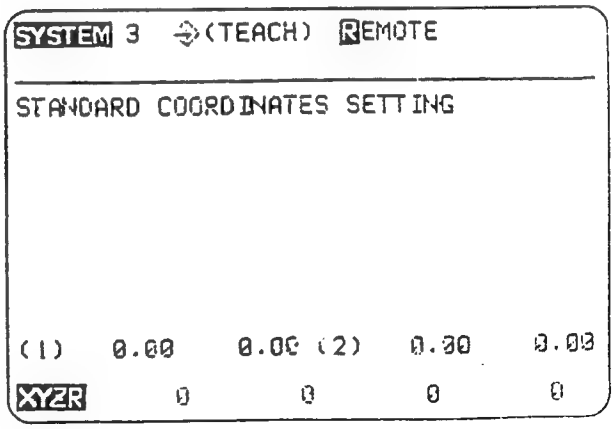
The x, y coordinate values of the points (1) and (2) which were used for last setting of the standard coordinates are displayed.



6) Touch [SPEED] :

This key changes the speed of arm movement.

Every time this key is touched, the speed changes in the order 3(low) → 2(medium) → 1(high) → 3.

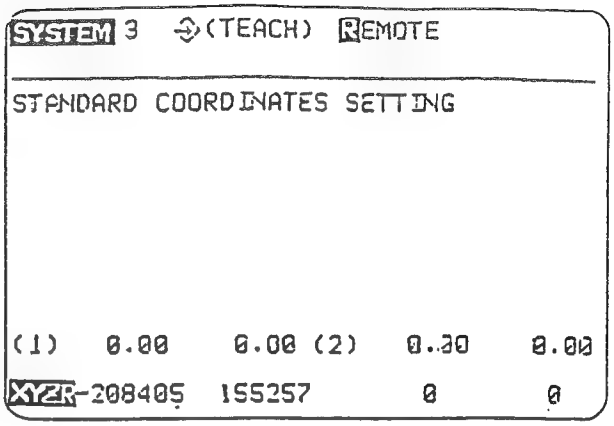


7) Touch [X+] [X−] [Y+] [Y−]:

- Move the tip of the Robot to the point(1) by these key.

  The tip of the Robot moves parallel to the axis of the present standard coordinate system.

  See FIG. 5-2.



- When the teach pendant is used for setting, proceed to following a. and b.

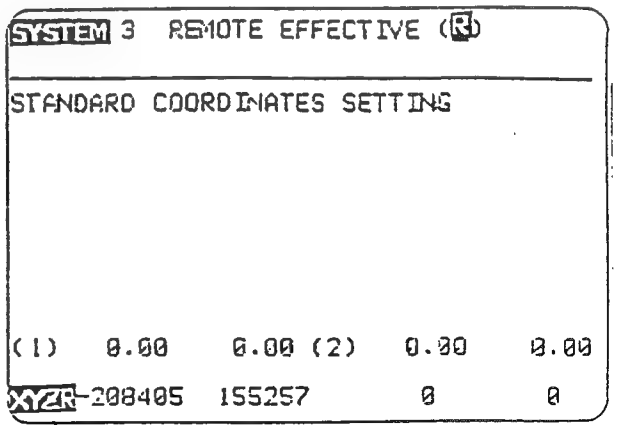
a. Touch [ ]:

  This key switches the Robot control to the teach pendant.

b. Touch [←] [→] [↑] [↓]:

  Move the tip of the Robot to the first Point (1) by these keys.

  See FIG. 5-2.



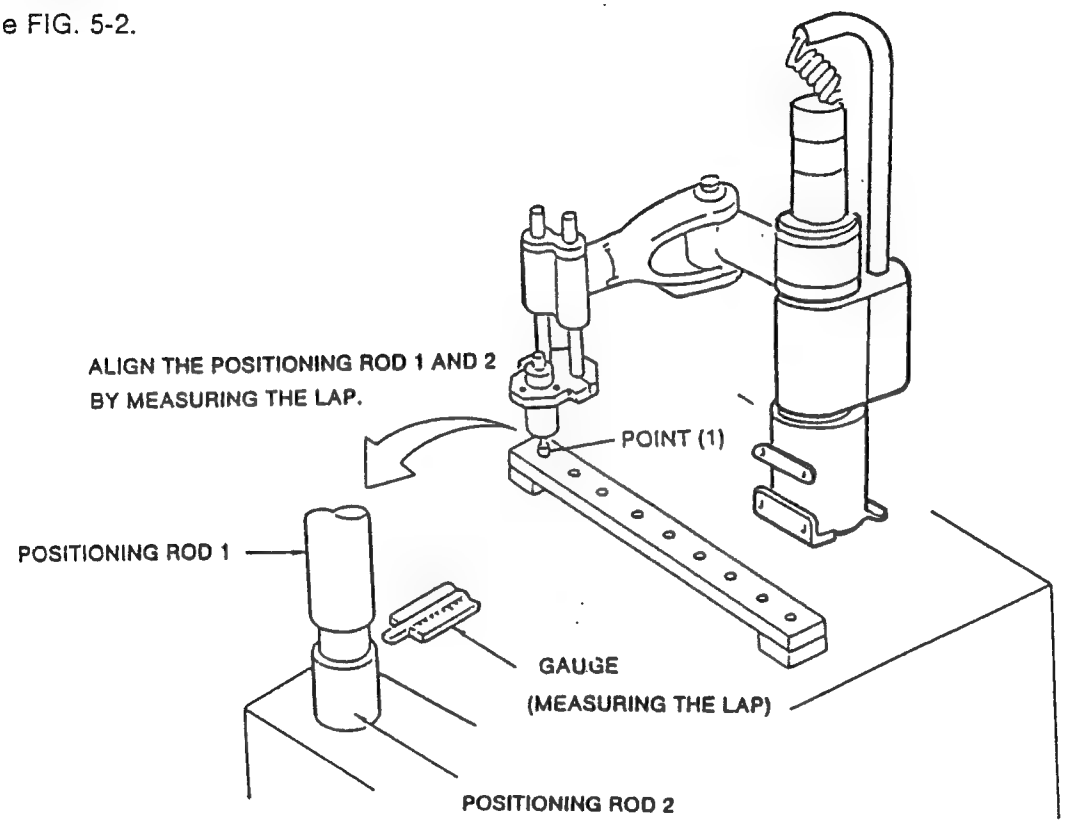
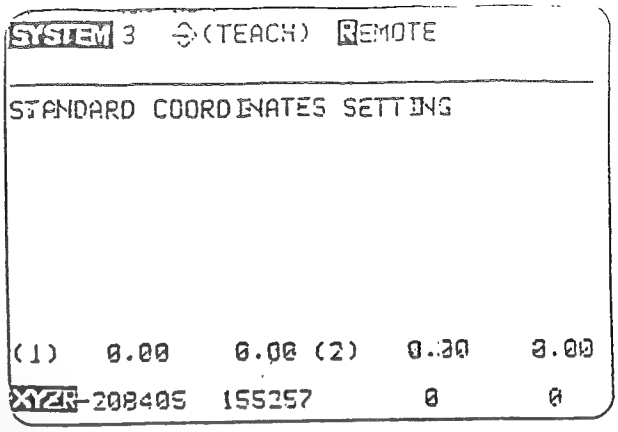


FIG. 5-2 Position of a Point (1)

8) Touch [→] :

This key teaches the first point (1) for co-ordinates setting. When touched the first time, the present position of the arm tip in the joint coordinate system is stored as the data for point (1).

NOTE:
The screen is not changed at this stage. (The cursor is not yet displayed.)



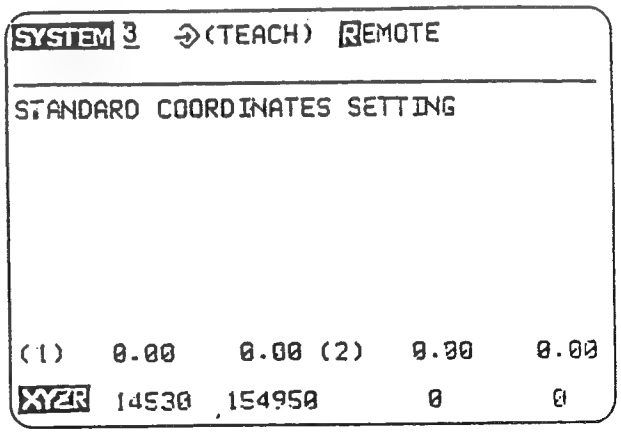
9) Touch [X+] [X−] [Y+] [Y−] :

When using the teaching box,

Touch [←] [→] [↑] [↓] :

Move the tip of the Robot to the second point (2) by these keys.

See FIG. 5-3.



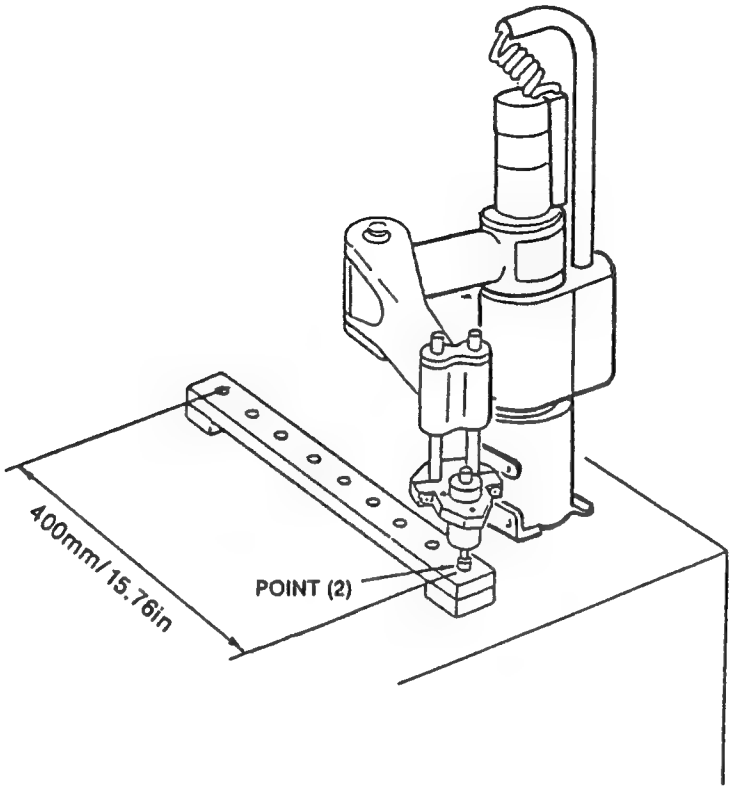


FIG. 5-3 Position of a Point (2)

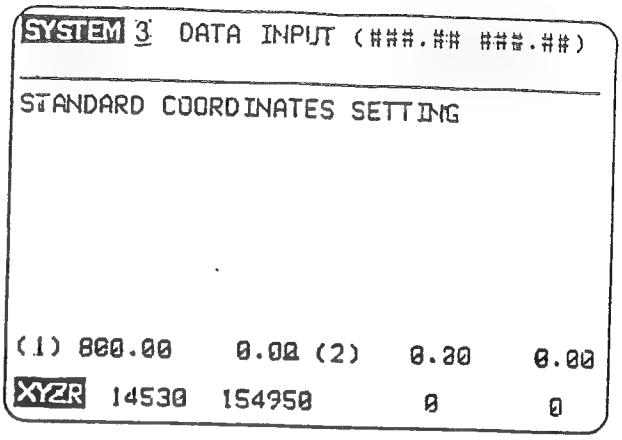
10) Touch  :

This key teaches the second point (2) for coordinates setting.

When touched the second time, the present position of the arm tip in the joint coordinate system is stored as the data for point (2).

Teaching is thus completed in two steps 8) and 10).

The message and cursor are displayed, prompting input of the coordinate values.



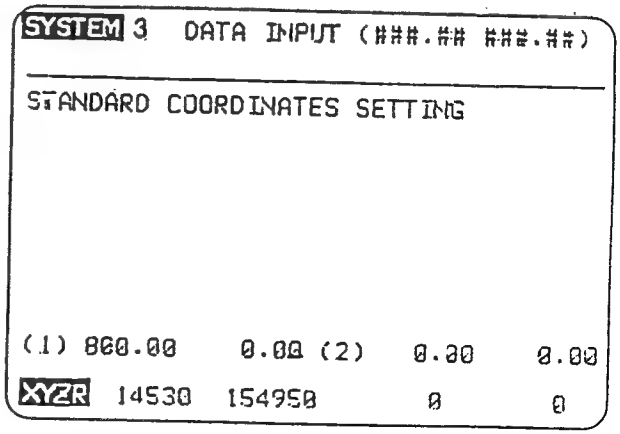
11) Touch SPACE 4 0 0 . 0 0 SPACE SPACE SPACE SPACE 0 . 0 0

These keys input coordinate values (400.00 0.00) of the point (1) in the X-Y coordinate system.

Format: ±###.## ±###.##

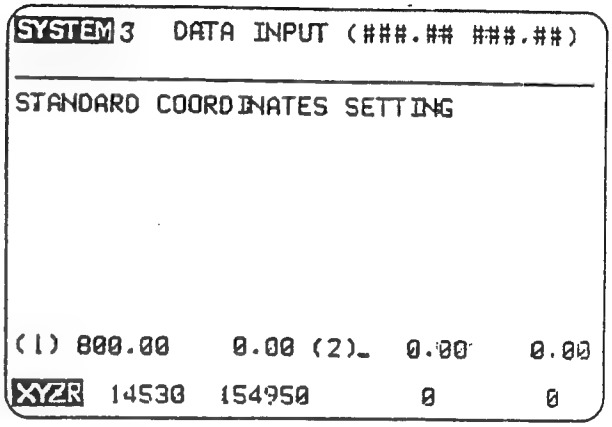
The + mark as well as preceding zeros and zeros following the decimal point can be omitted.

The edit keys can be used too.



12) Touch  :

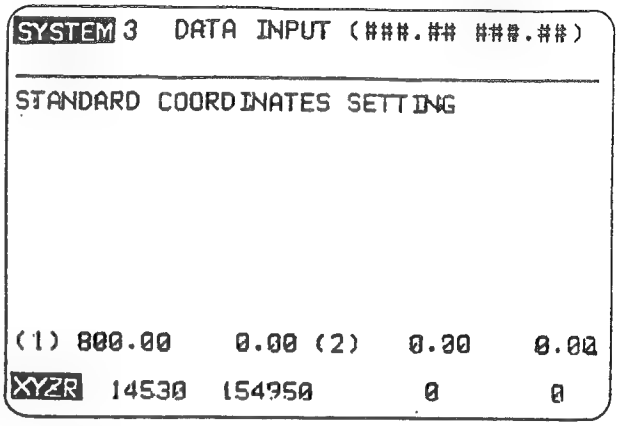
This key completes entry of the point (1) coordinate values. When it is completed, the cursor moves to point (2) inputting position.



13) Touch [SPACE] [SPACE] [SPACE] [0] [·] [0] [0] [SPACE] [SPACE] [SPACE] [SPACE] [0] [·] [0] [0]

These keys input coordinate values (0.00 0.00) of the point (2) in the X-Y coordinates system.

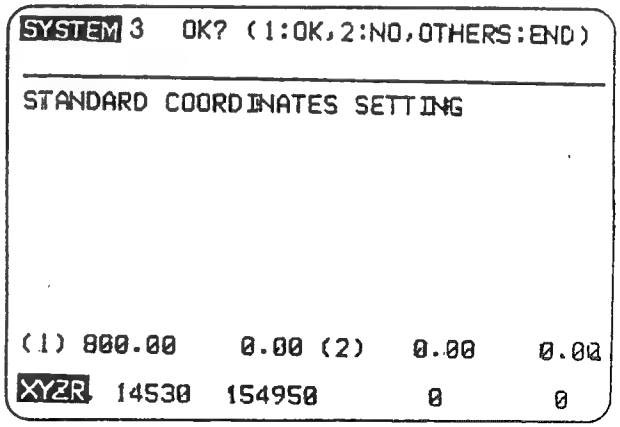
Same as 9).



14) Touch [→] :

This key completes entry of the point (2) coordinates values.

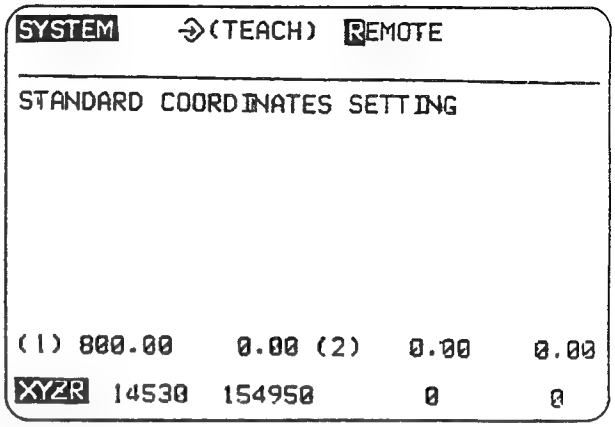
When it is completed, a confirmation message appears on the top of the screen.



15) Touch [1] :

This key completes the standard coordinates setting.

NOTE:
After having performed these process, proceed to 5-4-3 "STANDARD COORDINATES CHECKING PROCEDURE".



Or touch [2] :

For reentering the values of the point (1) and point (2), touch this key.

Or touch except [1] and [2] :

For canceling the standard coordinates setting procedure, touch this key.

The last standard coordinates then remain as they were after touching this key.

5-4-3 STANDARD COORDINATES CHECKING PROCEDURE

After having performed the standard coordinates setting procedure, check the Tobot operation in X-Y coordinate system as following step.

NOTE:
Don't move the setting tools positioned at 5-4-2.

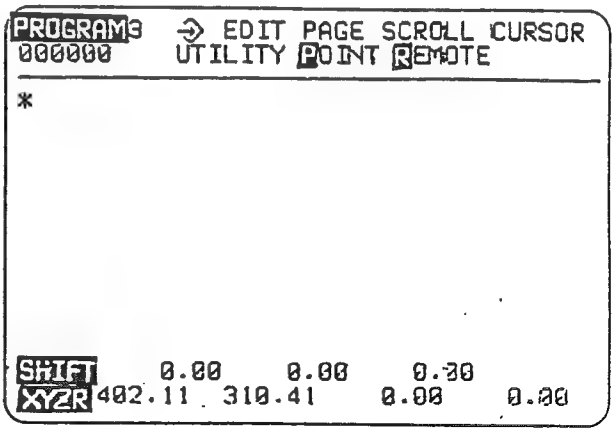
1) Move the tip of the Robot to the point (1) on the setting plate by using the "X+", "X−", "Y+", "Y−" keys in the Program or Point Data Mode.

2) Write down the point (1) data in the X-Y coordinate system.

   This screen shows the point (1) data:

   X = 202.11

   Y = 210.41



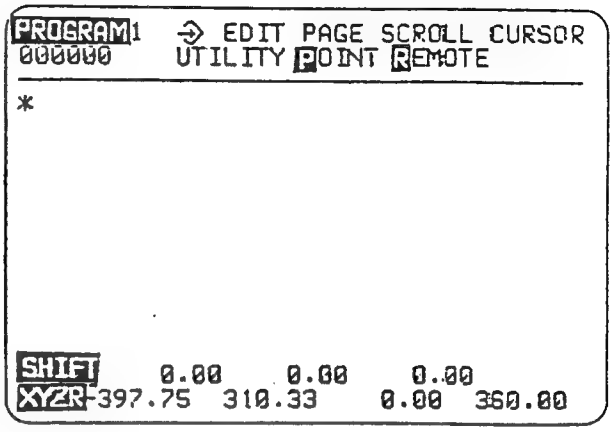
3) Same as 1), move the tip of the Robot to the Point (2).

4) Write down the point (2) data in the X-Y coordinate system.

   This screen shows the point (2) data:

   X = −197.75

   Y = 210.33



5) Calcurate the amount of a standard coordinates setting error by using above point (1) and (2) data as following example.

EX. Point (1) data : $X_1 = 202.11$, $Y_1 = 210.41$

Point (2) data : $X_2 = -197.75$, $Y_2 = 210.33$

$\therefore$ $X_1 - X_2 = 202.11 - (-197.75) = 399.86$ ..... (1)

$Y_1 - Y_2 = 210.41 - 210.33 = 0.08$ ..... (2)

When the standard coordinates setting has been performed properly, the results (1) and (2) are within the allowable ranges as followings.

(1) ..... 400.00 ± 0.20

(2) ..... ± 0.20

If the results (1) and/or (2) are out of the allowable ranges, perform 5-4-2 "STANDARD CO-ORDINATES SETTING PROCEDURE" again.

5-5 SHIFT COORDINATE SETTING

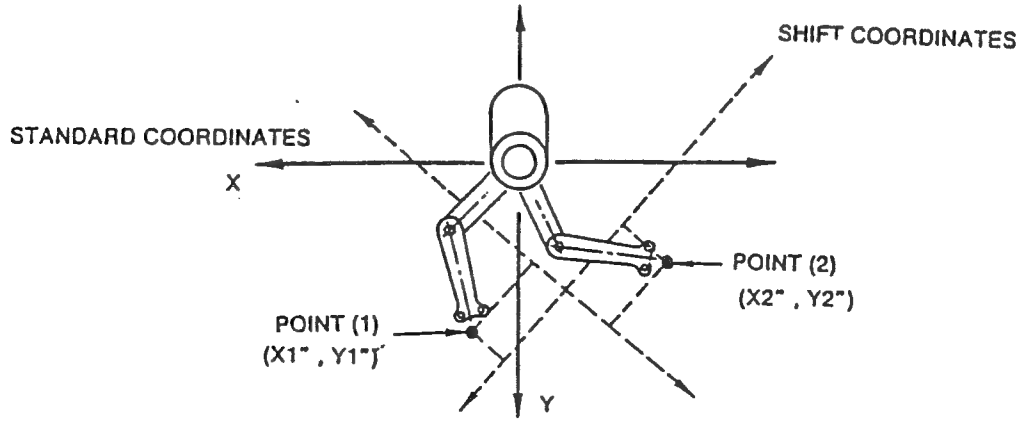
5-5-1 DESCRIPTION

Shift setting enables the entered point data (refer to the Point Data Mode) to be utilized as point data on the shifted coordinates.

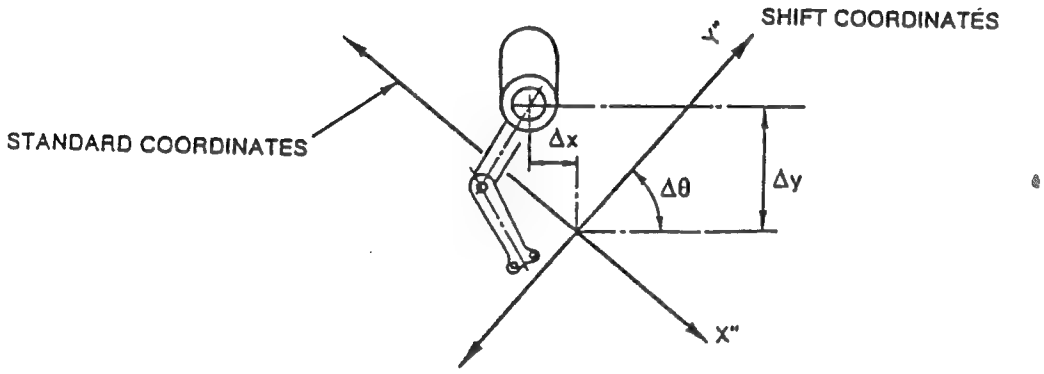
For example, if you want the Robot to perform the same steps on the same kind of work in multi-stations, the point data for the work can be shifted to each station for use, thus saving the number of the point data.

The following summarizes the shift coordinate setting.

1) Set the coordinates resulting from a parallel shift of the standard coordinates and from their rotation. If no standard coordinates have been set, an error occurs. As with the setting of the standard coordinates, any 2 points (1) and (2) are taught, and their shifted coordinate values (x1" ,y1") and (x2", y2") are entered via the keys.



2) The shift coordinates x", y" corresponding to the input coordinate values are set.



3) The amount of shift from the standard coordinates Δx [mm] Δy [mm] Δθ [deg] is calculated and stored as the data of the currently selected shift number.

(The coordinate values of points (1) and (2), which were entered via the keys, are also stored so as to prevent faulty operation.) Instead of using point teaching, it is also possible to input Δx, Δy, Δθ directly with the keys. (In that case, the coordinate values for points (1) and (2) are set to 0).

A maximum of 10 shift coordinates can be set.

5-5-2 SETTING BY POINT TEACHING

The following explains the procedure for teaching two points you want to set on the shift coordinates and automatically computing the shift amount of the standard coordinates.

1) Touch [SHIFT]:

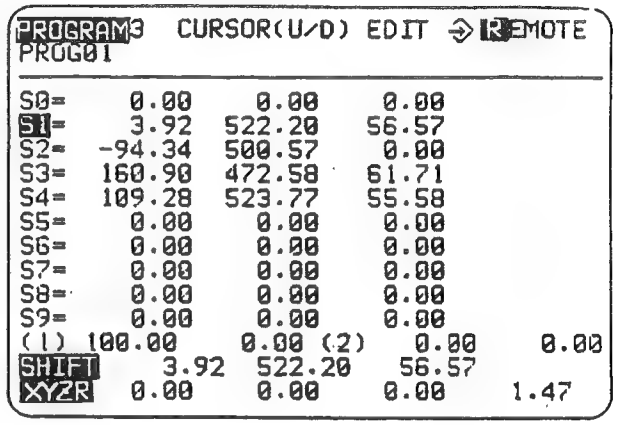
Thie key begins the setting of the shift coordinates.

A total of 10 shift coordinate setting values as well as the coordinate values of the 2 points used for the setting of the currently selected shift coordinates (displayed in reverse) are diaplayed.

Sn = ±###.## ±###.## ±###.##
Δx[mm] Δy[mm] Δθ[deg]

(1): ±###.## ±###.## = point (1) coordinate values [mm]

(2): ±###.## ±###.## = point (2) coordinate values [mm]

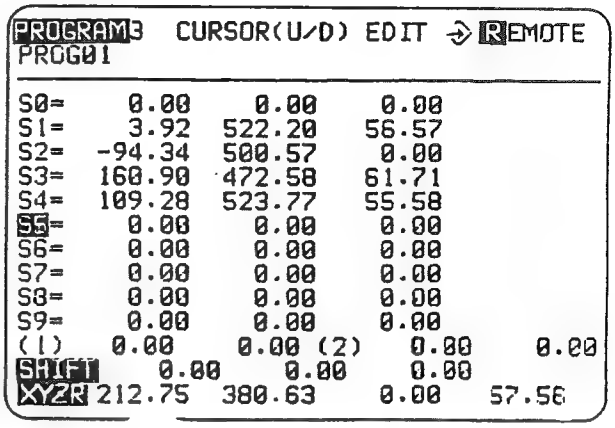


2) Touch [↑] or [↓]:

This key switches the shift coordinates.

The reverse video display of the shift number is moved up and dowm.

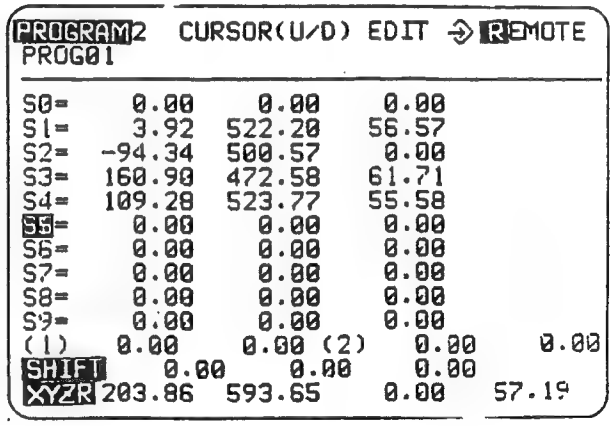
Display of the coordinate values for points (1) and (2) changes according to the shift number.



3) Touch [X+], [X−], [Y+], [Y−]:

These keys move the arms to teach point (1).

If the "SPEED" key is touched simultaneously, high-speed movement is achieved.

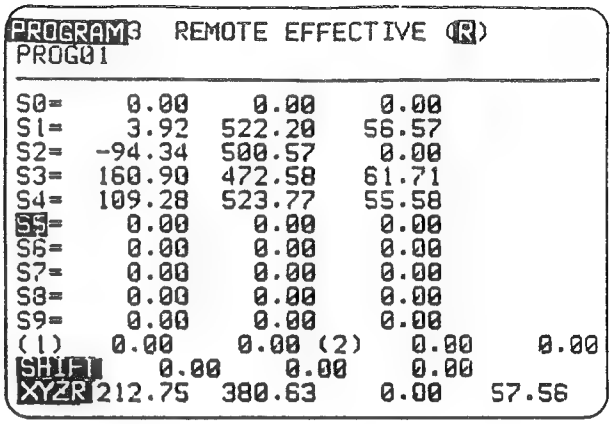


When using the teach pendant:

- Touch [R] :

This key switches the Robot control to the teach pendant.

The second touching of the "R" key returns the Robot control to the controller.

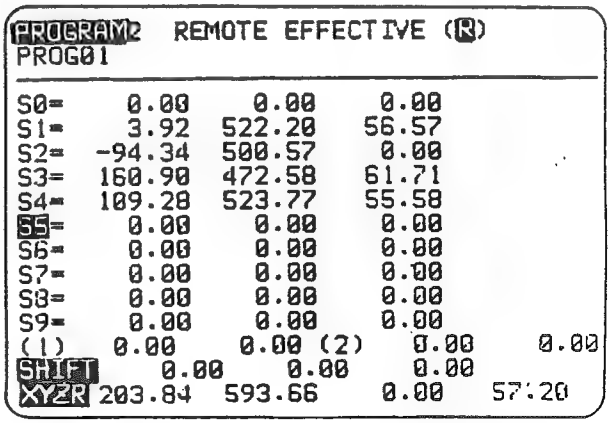


- Touch [←], [→], [↑], [↓]

(teach pendant keys):

These keys move the arms to teach point (1).

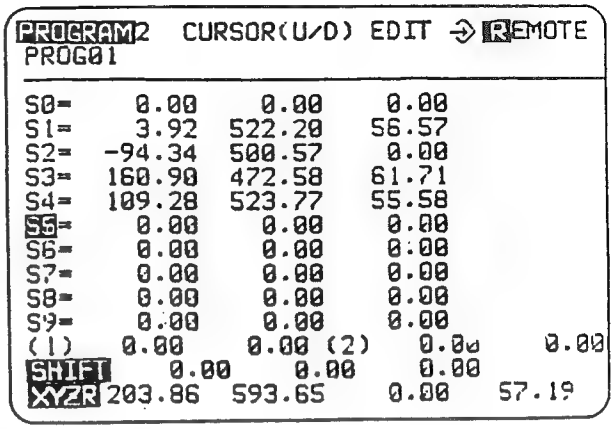
If the "~" key is touched simultaneously, high-speed movement is achieved.



4) Touch [⇨] :

This key teaches point (1) in the shift coordinate system.

NOTE:
This doesn't change display from 3). The cursor still doesn't appear.

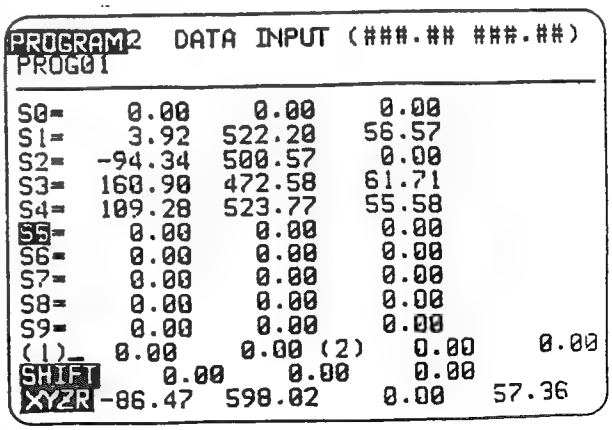


5) **Same as in 3).** This moves the arms in order to teach point (2).

6) Touch [⇨] :

This key teaches the point (2) in the shift coordinate system.

A message and the cursor are displayed, prompting the entry of the coordinate values.



7) Touch [0]~[9], [+], [−], [·]:

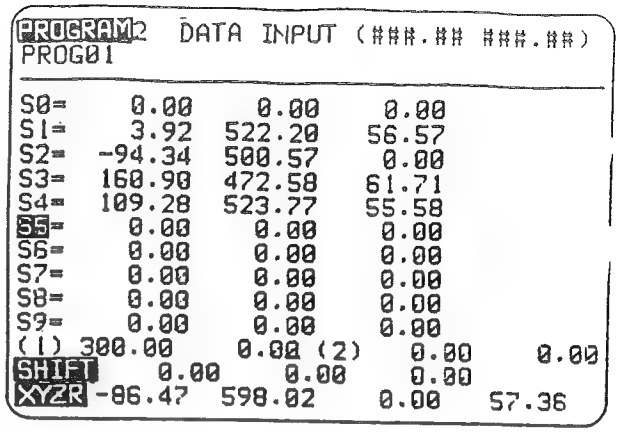
These keys input the point (1) coordinate value to the line indicated by the cursor. Data are divided by a space.

Data format:

±###.## ±###.##

The + mark, the preceding zeros and the zeros after the decimal point may be omitted.

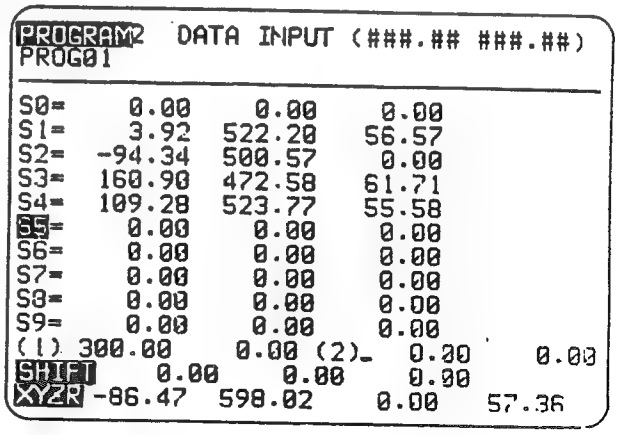
The cursor and edit keys are also effective.



8) Touch [⇨]:

This key completes the entry of the point (1) coordinate values.

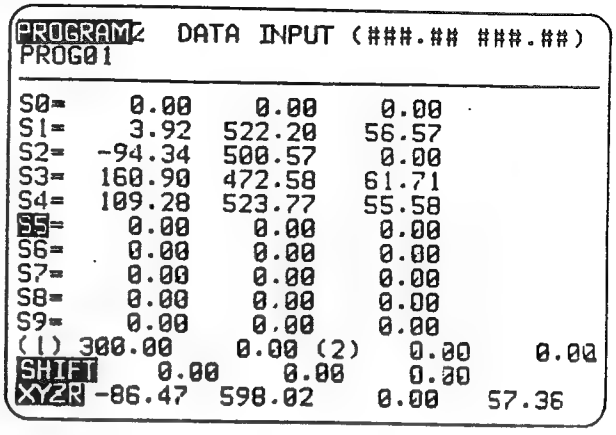
When entry for point (1) is completed, the cursor moves to the point (2) line.



9) Touch [0]~[9], [+], [−], [·]:

These keys input the point (2) coordinate values to the line indicated by the cursor.

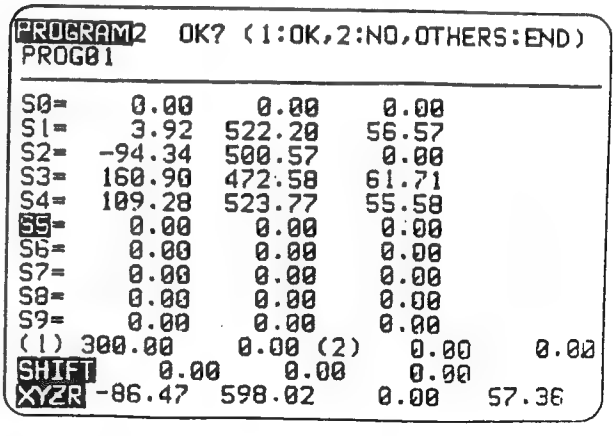
Same as in 7).



10) Touch [⇨]:

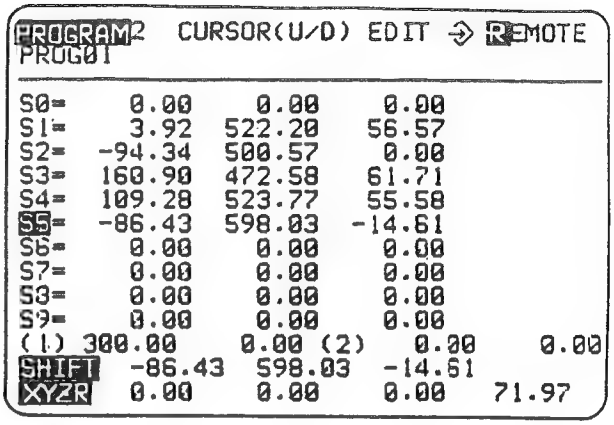
This key completes the entry of point (2) coordinate value.

When entry for point (2) is completed, a confirmation message appears on the top of the screen.



11) Touch [1] :

This key completes the setting of new shift coordinates.



If you want to re-enter coordinate values for point (1) and point (2):

Touch [2] :

If you want to cancel coordinate value entry:

Touch key except [1] and [2].

(This has no influence on the shift coordinates.)

5-5-3 SETTING BY MANUAL POINT DATA INPUTTING

The shift coordinates can be established by manually inputting the shift amount of the standard coordinates. If the shift coordinates thus established are designated in the program (see PROGRAMMING), the point data can be used such that they have undergone a parallel or rotary movement by the shift amount.

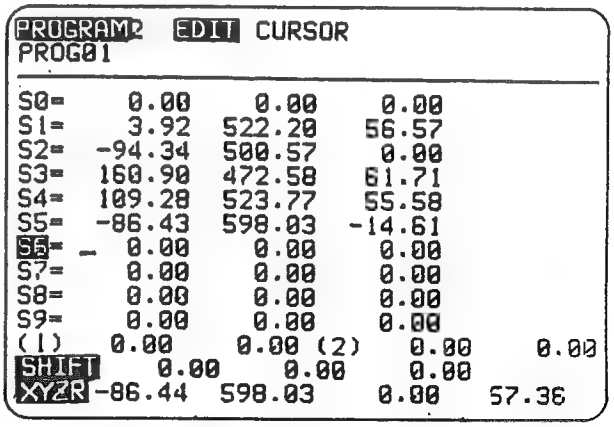
1) Touch [SHIFT] : Same as in 5-5-2 1).

2) Touch [↑] or [↓] : Same as in 5-5-2 2).

3) Touch [EDIT] :

In to edit the shift data, the shift coordinates are not set through teaching 2 points but through direct key entry of the shift data (Δx, Δy, Δθ).

The cursor appears at the location of the shift number displayed in reverse.

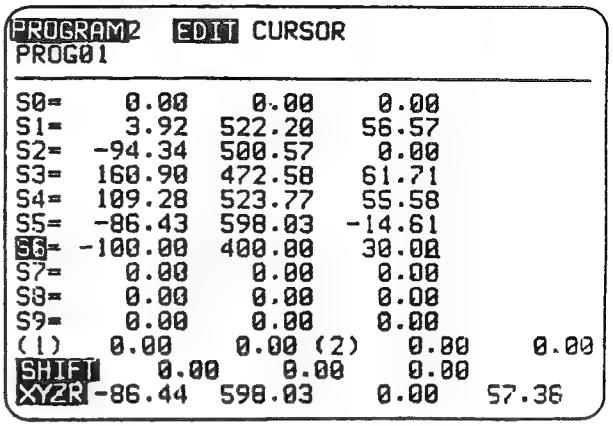


4) Touch [0] ~ [9], [+], [−], [·] :

To edit the data on the cursor line, data are divided by a space.
Data format:

±###.## ±###.## ±###.##

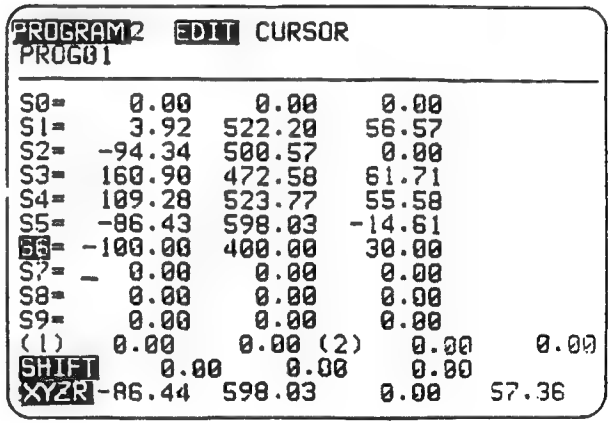
The + mark, the preceding zeros and the zeros after the decimal point may be omitted.
The cursor and edit keys are also effective.



5) Touch [⏎] :

This key completes the entry of one line of data.

The coordinate values of points (1) and (2) are set to 0. The cursor moves to the following line.



6) Touch [EDIT] :

This key completes the manual inputting of the shift coordinates data.
The cursor disappears from the screen.

5-6 ROBOT LANGUAGE

5-6-1 DESCRIPTION

A special language, similar to BASIC, designed by USR is used for the Maker Robot language for programmed operation. This enables the operator to handle complicated robot movements.

5-6-2 CHARACTERS

The Maker. Robot language employs the following characters.

a. Alphabetic Characters

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z

b. Numeric Characters

0, 1, 2, 3, 4, 5, 6, 7, 8, 9

c. Special Symbols

( ) + − * / = < > : , . #

5-6-3 FORMAT OF COMMAND STATEMENTS

Commands in the Maker Robot language are as follows.

[nn:] <statement>

"nn:" is the label (numerals from 1 to 99)

NOTE:
The bracketed ("[ ]") command statements may be ommitted.

5-6-4 EXPRESSIONS

There are 3 kinds of expressions: constants only, variables only, or combinations of constants and variables linked by the operator.

5-6-4-1 CONSTANTS

a. Decimal integer constants

Integers from −32768 to +32767

b. Binary constants

Binary numbers up to 8 bits. The letter B is affixed.

c. Point constants

A number indicates a point position. Point numbers consist of the letter P followed by up to 3 digits of numerals.

Examples: P1. P123

5-6-4-2 VARIABLES

a. Variables

Variables expressed by a single letter A, B ~ Z (except I, O, P).

b. Input Variables I # m [bit specification] m: port number 2 ~ 5

This input variable shows inputs condition.

If the bit specification has been omitted, all 8 bits are subjected.

Example: A = I # 3.

The DI 30 ~ DI 37 input condition is substituted for variable A.

A = I # 2 bit 5, 4, 1

Condition of DI 25,24,21 input is substituted for variable A (if all DI 27 ~ DI 20 bits are 1,A = 7)

c. Output Variables O # m m: port number 1 ~ 3

This output variable shows outputs condition.

Example: O # 1 = 3

3 is output to DO 17 ~ 10. (DO 10 and DO 11 are output.)

d. Point Variables

These show point positions using variables.

They indicate the point number by the letter P followed by one other letter (except I, O, P).

Examples: PA, PF

5-6-4-3 OPERATORS

a. Arithmetical Operators

*	Multiplication
/	Division
+	Addition
−	Subtraction

As far as the order of calculation is concerned, multiplication and division have priority over addition and subtraction.

To change the order of calculation, parentheses are used.

b. Relational Operators

=	Equal
< >	Not equal
< =	Equal or smaller
<	Smaller
> =	Larger or equal
>	Larger

Relational operators are used to compare two values. If the comparison is "true", the result is 1. If it is "false", the result is 0.

5-6-5 FORMAT OF POINT DATA

There are two formats of points data; the joint coordinate format and the XY coordinate format.

5-6-5-1 JOINT COORDINATE FORMAT

±nnnnnn (identical for XYZR)

Decimal integer constants with 6 digits or less including the + or − sign.

Units are [pulses].

5-6-5-2 X-Y COORDINATE FORMAT

±nnn.nn (identical for XYZR)

A decimal with a + or − sign, an integer part of 3 digits or less and a decimal part of 2 digits or less.

Units are:

X	mm
Y	mm
Z	mm
R	degree

NOTE:
The + sign may be omitted.

5-6-6 COMMAND STATEMENTS

5-6-6-1 POINT DEFINITION STATEMENT

This statement defines points in a user program. There are two ways of defining points; one performed directly by coordinate values and the other by point calculation expressions.

a. Direct Specification of the Coordinates

Format:

```
pm = X Y Z R
```

m: point number ..... 3 digits max.

X: X-axis coordinate value ..... 6 digits max.

Y: Y-axis coordinate value ..... 6 digits max.

Z: Z-axis coordinate value ..... 6 digits max.

R: R-axis coordinate value ..... 6 digits max.

Explanation:

Defines the coordinates of one point in the operational range of the robot.

Used when changing point data while executing a user program, etc.

NOTE:
Labels cannot be used. Only constants can be used as coordinate values.
The data for X Y Z R are divided by spaces.

Examples:

```
P1   = 100000 -200000   -1000     1234
P123= 100.00 -200.00    80.00    10.00
```

b. Definition Using Expressions

Format:

```
[ nn: ] Pm = <expression>
```

Operators that can be used in the expression are * / + − = only.

Parentheses cannot be used.

Explanation:

Defines the point using the value of the expression.

Examples:

P1 = P100	Substitutes point 100 for point 1.
P200= P200+P5	Adds the data of point 200 and point 5 to each element, using this as the new data for point 200.
P300= P300-P3	Subtracts the data of point 3 from the data of point 300 and uses this as the new data for point 300.

P80 = P70*A — Multiplies each data element of point 70 by A and uses the result as the data for point 80.

P60 = P5/3 — Divides each data element of point 5 by 3 and uses the result as the data for point 60.

NOTE:
The five kinds of operators that can be used with point constants and point variables are +, −, *, / and =. * and / are for multiplication and division by coefficients and cannot be used for multiplication or division of point constants or point variables.

Examples: **P10*5 ..... possible**
PE/3 ..... possible
P10*P12 ..... not possible

5-6-6-2 "INPUT/OUTPUT" STATEMENTS

Manipulate DI, DO inputs and outputs.

Inputs and outputs of DI, DO are also possible using substitution statements.

a. Input standby

Format:

```
[ nn: ] WAIT#m  <8 bit binary integer>
[ nn: ] WAIT#m  <Bit designation = value>
[ nn: ] WAIT#m  <Decimal integer constants>
```

m: port number 2 ~ 5

Explanation:

Waits until the DI input condition corresponds to the specified condition after the axis movement is finished.

Examples:

WAIT#2 01010110B ------ Waits for DI 21,22,24 and 26 to be on, DI 20,23,25 and 27 to be off.

WAIT#2 BIT4,3,2=101B--- Waits for DI 22 and 24 to be on, DI 23 to be off.

WAIT#2 15 ------------ Waits for DI 20,21,22 and 23 to be on, DI 24,25,26 and 27 to be off.

b. Output

Format:

```
[ nn: ] OUT#m  <8 bit binary integer>
[ nn: ] OUT#m  <Bit designation = value>
[ nn: ] OUT#m  <Decimal integer constants>
```

m: port number 1 ~ 3

Explanation:

Outputs the specified value to DO.

If the axis is currently moving, output is performed as soon as the movement is completed.

Examples:

```
OUT#1 10111000B . . . . . DO 13,14,15 and 17 are on. DO 10,11,12 and 16 are off.
OUT#1 BIT6,5,1=010B . . . DO 15 is on. DO 11 and 16 are off.
OUT#1 15 . . . . . DO 10,11,12 and 13 are on. DO 14,15,16 and 17 are off.
```

5-6-6-3 "GOTO" STATEMENT

Format:

```
[ nn: ] GOTO nn
```

nn = label of jump destination

Explanation:

Performs an unconditional jump to the line indicated by the label nn.

Example:

```
GOTO 30
 :
30:...
```

5-6-6-4 "IF" STATEMENT

Format:

```
[ nn: ] IF <expression> THEN nn
```

nn = label of jump destination

Explanation:

If the condition posed by the expression is fulfilled, execution jumps to the line whose number is indicated by nn. If the condition is not fulfilled, the next line is executed.

Example:

```
IF A=1 THEN 20
IF 1BIT5,4,3=110B THEN 30
      :
20:... .
      :
30:...
```

5-6-6-5 "CALL" STATEMENT, "RETURN" STATEMENT

These statements are used to call a subroutine and then return.

CALL can be used up to 40 times in a row.

Format:

```
[ nn: ] CALL nn
  :
nn:
  :
      RETURN
```

nn = subroutine start label

Explanation:

Jumps to the subroutine indicated by label nn and executes it. When a RETURN statement is encountered during execution, the program returns to the line following the CALL statement.

Example:

```
    CALL 10
10: "SUBROUTINE
    :
    RETURN
```

5-6-6-6 "FOR" STATEMENT, "NEXT" STATEMENT

These commands cause repeated operation.

Format:

```
[ nn: ] FOR <variable> = <expression 1> TO <expression 2> [STEP <expression
3>]
  :
NEXT <variable>
```

Explanation:

While altering the value of the <variable> by the value of <expression 3> each time, starting with the value of <expression 1>, the statements between the statement following the FOR repeatedly until the value of the <variable> becomes the value of <expression 2>. The value of <expression 3> may be negative.

NOTE:
If the value of <expression 3> in the FOR statement is 1, [STEP <expression 3>] may be omitted.

Example:

```
FOR A=1 TO 5
:
FOR B=10 TO 0 STEP-2
:
```

Format:

```
[ nn: ] MOV  <point designation>  [<speed specification>]
[ nn: ] CP   <point designation>  [<speed specification>]
```

Explanation:

- MOV and CP are used to instruct the robot arm movement.

  MOV instructs PTP (point to point) operation.

  CP instructs CP (continuous path) operation.
- Speed is specified in % by VEL statement. Default value is the unchanged previous speed.

Examples:

`MOV P1`	Moves to point 1.
`10000 -20000 30000 40000`	Moves to the specified value.
`CP P2 VEL 70`	Moves straight to P2 at 70% speed.

NOTE:
Speed specified with MOV and CP applies to either the X or the Y axis, depending on which axis the distance is greater. For this reason, the results of the movement along the X and the Y axes will depend on the position along the axis, even if the same speed is specified. Use the VEL function for fixed linear velocity specification with CP, and adjust the speed at the specified denominator.

a. Point Designation

1) Direct Coordinate Designation

Format:

```
X Y Z R
```

X: X-axis coordinate value
Y: Y-axis coordinate value
Z: Z-axis coordinate value
R: R-axis coordinate value

The data for X, Y, Z, and R are divided by spaces.

2) Designation by Point Definition

Format:

```
Pm
```

m: point number (constant or variable) 0 T 999

b. Speed Specification

Format:

VEL <expression>

Explanation:

Speed is specified by the value of the expression. Valid only for the command statements in the same line.

5-6-6-8 "STOP" STATEMENT

Format:

[nn:] STOP

Explanation:

When the STOP statement is executed, the program is stopped and reset. Touching the "RUN" key restarts the program from the beginning.

5-6-6-9 COMMENT STATEMENT

Format:

" <comment>

Explanation:

Anything following the inverted commas " is regarded as a comment.

Example:

```
10: CALL 30"ABCDEF***
```

5-6-6-10 SUBSTITUTION STATEMENT

Format:

[nn:] <variable> = <expression>

Explanation:

Substitutes the value of the expression for the variable.

Examples:

```
A=10
A=B*C
A=1#2        Substitutes the DI 27 ~20 input for variable A.
0#1=A        Outputs the value of A to DO 17 ~ 10. (A must have a value under 255.)
```

5-6-6-11 LABEL STATEMENT

Format:

```
nn:
```

Explanation:

Defines a lavel for a line.

A " mark is automatically set in the column following the label.

Example:

```
GOTO 10
...
10:"
P123= 123456 -123456 -123456     1234
FOR A=1 TO 10
```

5-6-6-12 TIMER STATEMENT

Format:

```
[ nn: ] TIMER  <expression>
```

The value of the expression must be between 1 and 6552.

Explanation:

Waits for the time specified by the expression after movement is finished. The units of the expression value are [1 / 10 sec].

Examples:

```
10: TIMER 30
20: TIMER A*10
```

5-6-6-13 SPEED SETTING STATEMENT

Format:

```
[ nn: ] VEL  <expression>
```

The value of the expression must be between 1 and 100. Units are %.

Explanation:

Changes speed to the value specified by the expression.

Example:

```
VEL 70
VEL A*10
MOV P1 VEL 30 ..... Speed changes to 30% only when moving to point 1.
```

5-6-6-14 SHIFT COORDINATE SETTING STATEMENT

Sets the shift coordinates to the shift data previously defined.

Format:

```
SHIFT Sn
```

n is a numeral from 0 to 9.

Explanation:

Sets the shift coordinates to the shift data of number n.

Examples:

```
SHIFT S5
MOV P10.....The data of point 10 are regarded as the position according to the shift
            coordinates.
```

Point 10 must be defined beforehand using X-Y coordinates.

5-6-6-15 SEND STATEMENT

This statement transmits data from one file to another file.

Format:

```
[ nn: ] SEND <file 1> TO <file 2>
```

Explanation:

Transmits the data of file1 to file2.

Kinds of file1 : Program, point data, parameter
Kinds of file2 : Printer (device file)

File format:

a. Program file:

- PGM ..... All programs which are stored in the controller.
- < x x x x x x > ... One program which is named " x x x x x x ".

b. Point data file:

- PNT ..... All points (P0 ~ P999).
- Pn ..... Point constant (n = 0 ~ 999).
- P$ ..... Point variable ($ = A ~ Z, except I,O and P).
- Pnnn ..... Auto increment type of point constant (n = 0 ~ 9 or " − "). When using " − ", it increases automatically from 0 to 9.

  ex. P− means P0,P1,P2, ~ P9.
  P2− means P20,P21,P22, ~ P29.

c. Parameter file:

PRM..... All parameter data (standard and option)

d. Device file:

PRN ..... Device of printer

Examples:

```
10:  SEND PGM TO PRN
     SEND <ABC> TO PRN
     SEND PNT TO PRN
     FOR A=1 TO 10
     SEND PA TO PRN
     NEXT A
     SEND P1-- TO PRN
     SEND PRM TO PRN
```

5-6-7 TABLE OF COMMAND STATEMENT

TYPE STATEMENT	FORMAT	EXAMPLES	MEMORY USE (BYTES)
POINT DEFINITION STATEMENT	Pm = X Y Z R	P123 = −123456 123456 123456 1234	19
	Pm = <expression>	P1 = p1000 p200 = p200 + p5 P300 = P300 − p3 P80 = P70 * A P60 = p5 / 3	12 16 16 15 16
DI INPUT STANDBY	FORMAT · WAIT# <PORT NUMBER> <8 BIT BINARY CONSTANT> · WAIT# <PORT NUMBER> <BIT DESIGNATION> = <VALUE> · WAIT# <PORT NUMBER> <DECIMAL INTEGER CONSTANT>	· WAIT#2 10101011B · WAIT#2 BIT 3,1 = 01B · WAIT#2 33	8 10 8
DO OUTPUT	FORMAT · OUT# <PORT NUMBER> <8 BIT BINARY CONSTANT> · OUT# <PORT NUMBER> <BIT DESIGNATION> = <VALUE> · OUT# <PORT NUMBER> <DECIMAL INTEGER CONSTANT>	OUT#1 10111000B OUT#1 BIT 7,5 = 10B OUT#1 33	8 10 8
JUMP	GOTO nn	GOTO 30	7
DECISION	IF <EXPRESSION> THEN nn	IF A = 1 THEN 20	14
SUBROUTINE	CALL nn : RETURN	CALL 10 : RETURN	7 4
REPEAT	FOR <VARIABLE> = <EXPRESSION 1> TO <EXPRESSION 2> [STEP <EXPRESSION 3>] : NEXT	FOR A = 10 TO 4 STEP −2 : NEXT A	20 5
MOVEMENT	[MOV] <POINT DESIGNATION> [SPEED SPECIFICATION]	MOV P100 123456 −123456 123456 1234	8 18
	CP <POINT DESIGNATION> [SPEED SPECIFICATION]	CP P2 VEL 70	13
COMPLETION OF OPERATION	STOP	STOP	4
COMMENT STATEMENT	' <COMMENT>	' SUBROUTINE ***	18
SUBROUTINE STATEMENT	<VARIABLE> = <EXPRESSION>	A = 10 B = C * D	11 13
TIMER STATEMENT	TIMER <EXPRESSION>	TIMER 10 TIMER A * 10	8 11
SPEED SETTING	VEL <EXPRESSION>	VEL 70 VEL A * 10	8 11
SHIFT COORDINATE SETTING	SHIFT Sn	SHIFT S5	5
LABEL STATEMENT	nn :	23 :	4
TRANSMISSION	SEND <FILE 1> TO <FILE 2>	SEND PGM TO PRN SEND <000000> TO PRN SEND PNT TO PRN SEND PRM TO PRN	9 16 9 9

5-7 SAMPLE USER PROGRAMS

5-7-1 POINT TO POINT OPERATION BY DIRECT POINT DATA CODING

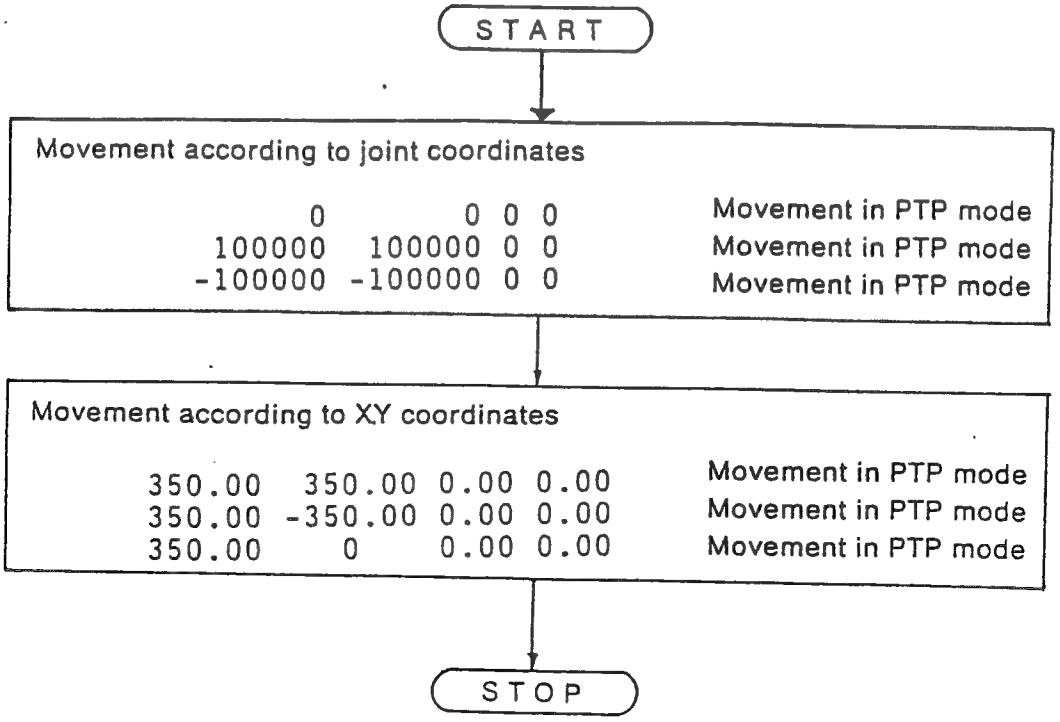
a. Description

This specifies the joint and XY coordinate values in the programs for PTPs with robot arms.

For the shift coordinates, $\Delta X = \Delta Y = \Delta\theta = 0$

(Equivalent to the standard coordinates.)

b. Processing flow



c. Sample program

```
MOV        0         0       0       0
MOV   100000
MOV  -100000  -100000     0.00    0.00
MOV   350.00   350.00     0.00    0.00
MOV   350.00  -350.00     0.00    0.00
MOV   500.00     0.00     0.00    0.00
STOP
```

5-7-2 POINT TO POINT OPERATION BY INDIRECT POINT NUMBER CODING

a. Description

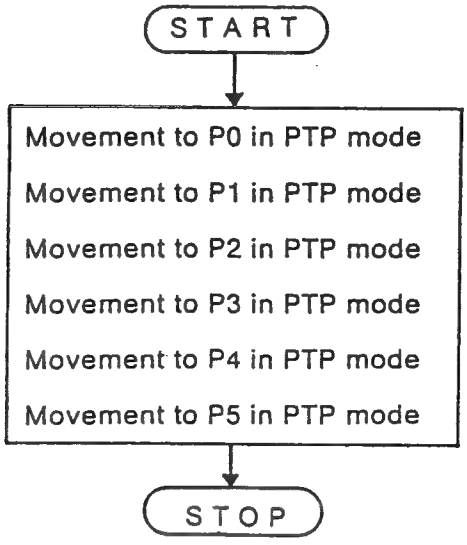
Use point numbers in the program to specify coordinate values.

Coodinate values are stored in the point numbers in advance when the Point Data Mode is used.

Use the following as data:

P0=	0	0	0	0
P1=	100000	100000	0	0
P2=	-100000	-100000	0	0
P3=	350.00	350.00	0.00	0.00
P4=	350.00	-350.00	0.00	0.00
P5=	500.00	0.00	0.00	0.00

b. Processing flow



c. Sample program

```
MOV P0              FOR J=1 TO 5
MOV P1              MOV PJ
MOV P2              NEXT J
MOV P3     or       STOP
MOV P4
MOV P5
STOP
```

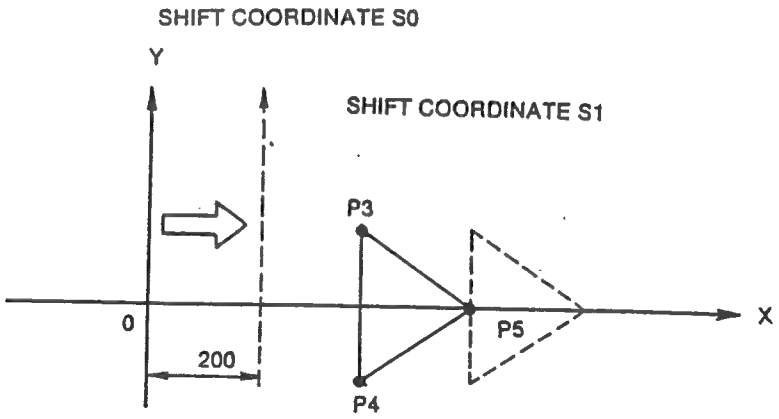
5-7-3 USING SHIFT COORDINATES

a. Description

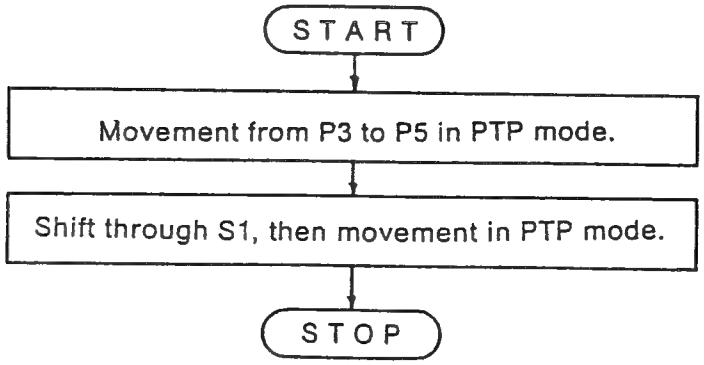
Move in the PTP Mode from P3 to P5 on the XY coordinate plane as shown in the figure.

Next, shift the Y axis by +200 in the X direction, then move again from P3 to P5 in the PTP Mode.

Store the value for coordinate shifting in S1. Use the values stored in 5-7-2 for P3, P4, and P5.



b. Processing flow



c. Sample program

```
SHIFT S0
FOR J=3 TO 5
MOV PJ
NEXT J
SHIFT S1
FOR K=3 TO 5
MOV PK
NEXT K
STOP
```

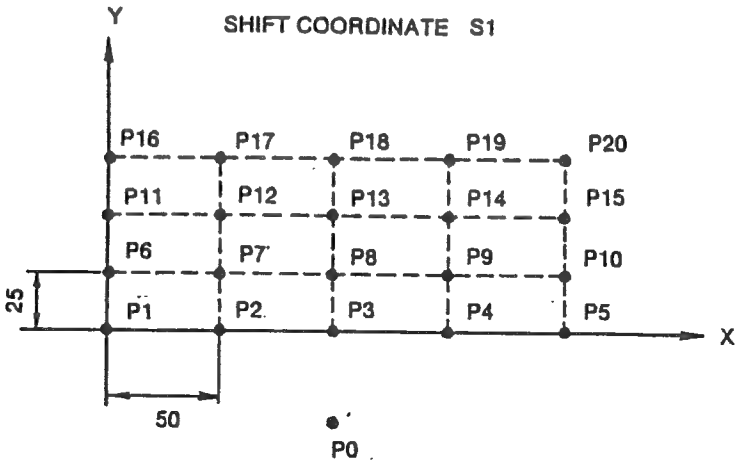
5-7-4 PALLET SIMULATION

a. Description

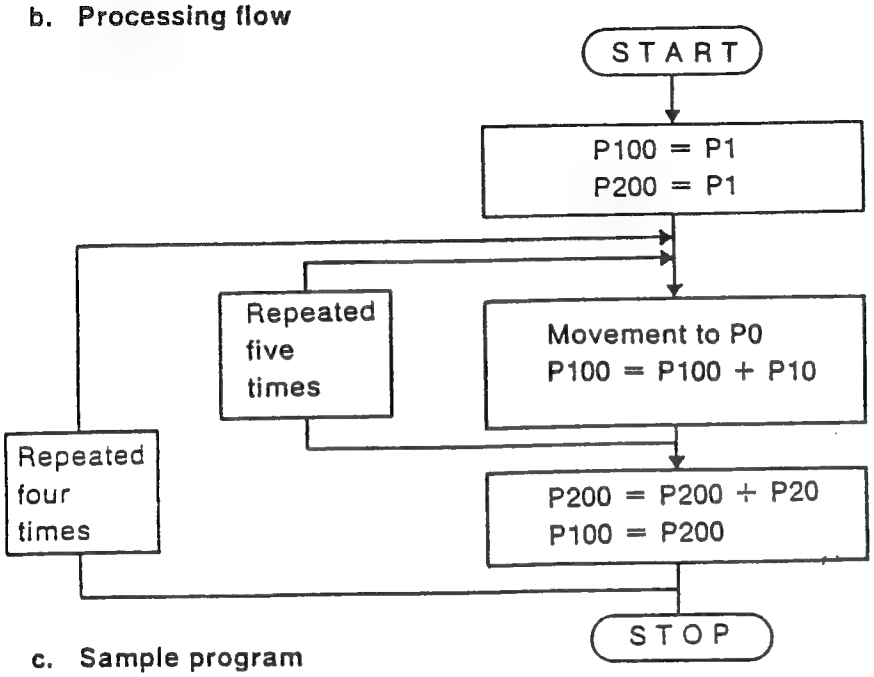
This programs alternately moves points on the pallets spaced at equal distances and the workpiece supply position P0.

In this figure, points P1 to P20 include the five points in the X direction at a pitch of 50mm and four points in the Y direction at a pitch of 25mm. The arm will move from point to point, thus P1 – P0 – P2 ..... P5 – P0 – P6 – P0 .....

Pitch along X axis: P10 = 50.0 0.0 0.0 0.0
Pitch along Y axis: P20 = 0.0 25.0 0.0 0.0
set these points in the initial position P1 = 0.0 0.0 0.0 0.0 Point Data Mode.



b. Processing flow



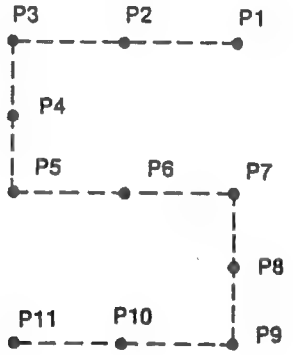
c. Sample program

```
SHIFT S1
P100=P1
P200=P1
FOR J=1 TO 4
FOR K=1 TO 5
MOV  P100
MOV  P0
P100=P100+P10
NEXT K
P200=P200+P20
P100=P200
```

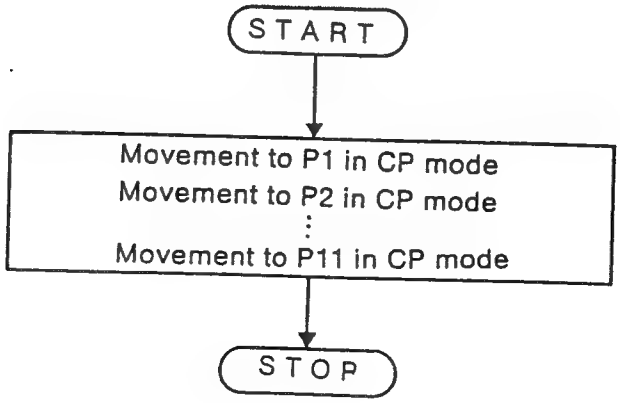
5-7-5 CP (CONTINUOUS PASS) OPERATION

a. Description

This consists of teaching point P1 to P11 on the coordinate plane, then connecting the points for movement by applying the CP movement.



b. Processing flow



c. Sample program

```
FOR J=1 TO 11
CP PJ
NEXT J
STOP
```

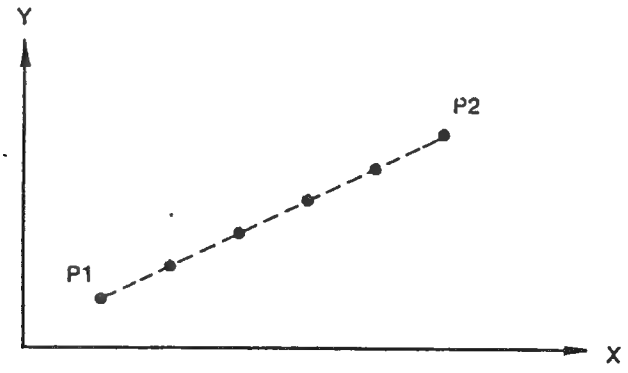
5-7-6 LINEAR MOVEMENT BETWEEN TWO POINTS

a. Description

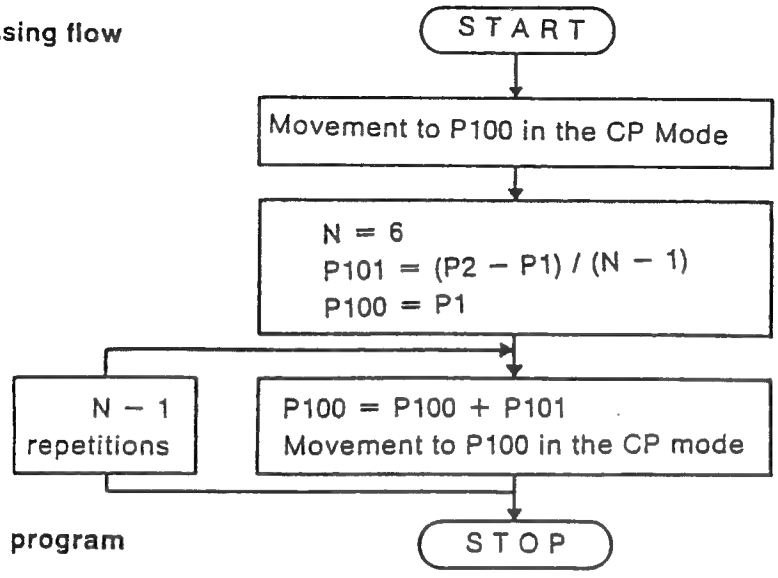
This teaches points P1 and P2, then interpolates the distance between them for more linear movement between the two points. If N stands for the number of interpolation points (including P1 and P2), then the position of the ith point is as follows:

$$P(i) = P(i-1) + \frac{P2 - P1}{N - 1} \times (i - 1) \quad ; i = 2 \sim N \ , \ P(i) = Pi$$

Points P1 and P2 on the coordinate plane. Also a program generated is taught for the CP operation from P1 to P2 using N = 6 (that is, six points for interpolation). The interpolated point is to be stored at P100. Assume that the robot is programmed to operate in the X-Y coordinate plane alone.



b. Processing flow



c. Sample program

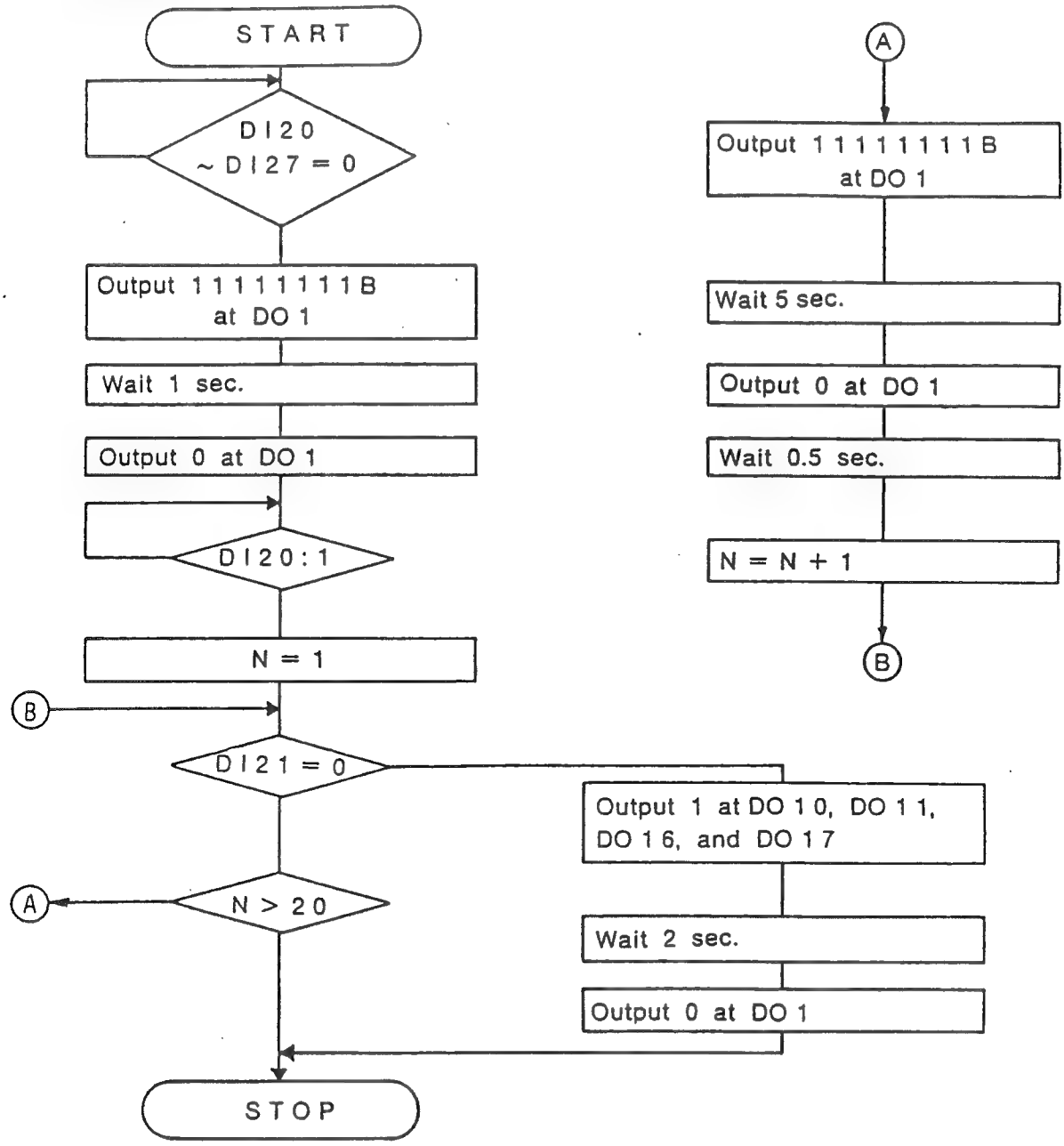
```
MOV P1
N=6
M=N-1
P101=P2-P1
P101=P101/M
P100=P1
FOR L=1 TO N-1
P100=P100+P101
CP P100
NEXT L
STOP
```

5-7-7 DI/DO (DIGITAL INPUT/DIGITAL OUTPUT) OPERATION

a. Description

General-purpose I/O devices are used for signal input and output.

b. Processing flow



c. Sample program

```
        WAIT#2 0
        OUT#1 11111111B
        TIMER 10
        OUT#1 0
        WAIT#1 BIT 0=1
        N=1
10:     IF 1#2 BIT 1=1 THEN 20
        IF N>20 THEN 30
        OUT#1 11111111B
        TIMER 5
        N=N+1
        GOTO 10
20:     OUT#1 BIT 7,6,1,0=1111B
        TIMER 20
        OUT #10
30:     STOP
```

5-7-8 POINT DATA INSERTION IN POINT DATA MODE

[Method 1] Using the Copy Utility

Use the utility copy command to transfer the group point data to different points. Next, move to the location corresponding to the number of points transferred.

(Example)

P10 = ———

One point insertion

P11 = ———

:

:

:

P100 = ———

(1) Copy P11 to P100 at P200 onwards

(2) Copy P200 to P289 at P12 onwards

[Method 2] Generate a program for insertion

Transfer point data by executin the NC program.

(Example)

```
FOR A=100 TO 11 STEP -1
B=A+1
PB=PA
NEXT A
STOP
```

CHAPTER 6
INPUT/OUTPUT INTERFACE

CHAPTER 6
INPUT/OUTPUT INTERFACE

6-1 DESCRIPTION

This Robot is provided with various inputs and outputs in order to be able to perform pick-and-place, screw tightening and similar operations in accordance with the requirements of the user's system. This chapter explains various digital input (DI)/output (DO) connections. Be sure to follow the directions given here for correct and effective operation.

In the standard version, the controller has 7 dedicated and 8 general purpose input terminals (expansion up to 32 general purpose input terminals are possible as an option), and has 6 dedicated and 8 general purpose output terminals are (expansion up to 24 general purpose output terminals are possible as an option).

These terminals are wired to the connectors I/O CN 1 (standard) and I/O CN 2 (option) on the lower part of the controller.

NOTE:
Expanded input/output is included with optional servo-Z and/or servo-R axes.

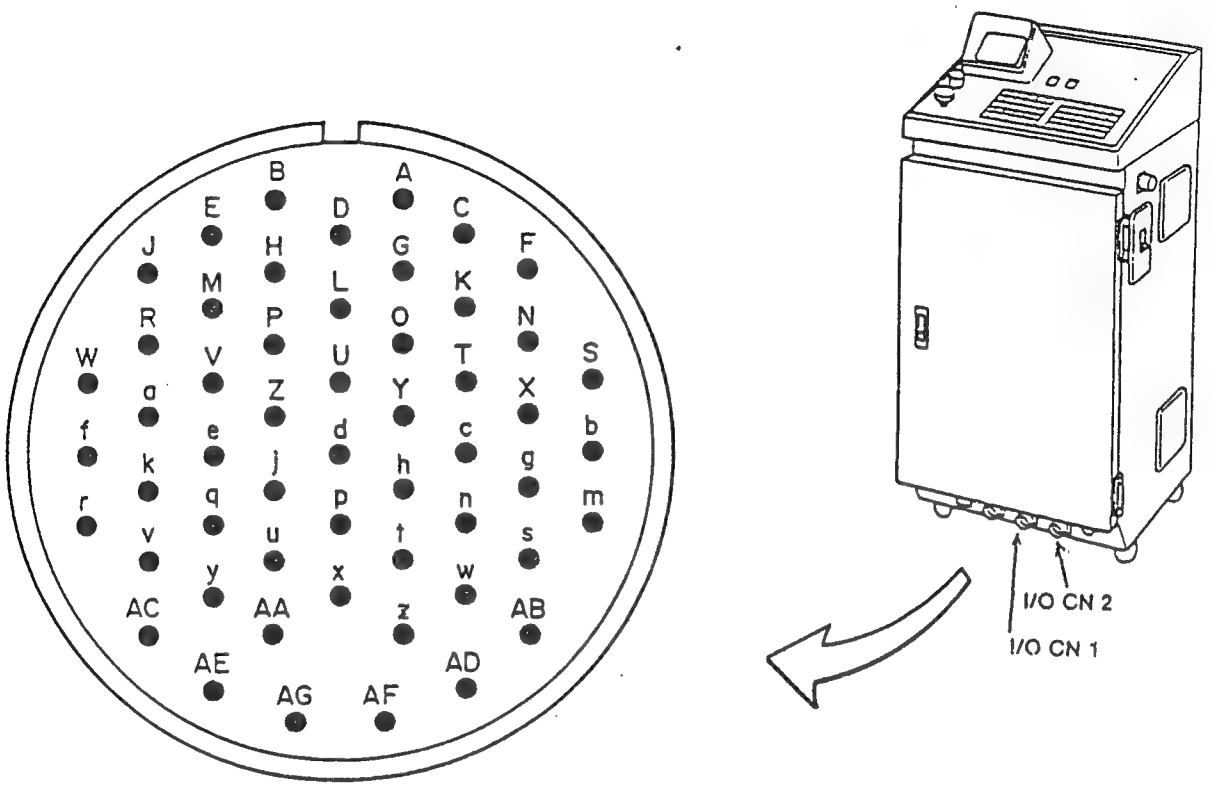


FIG. 6-1 I/O Terminals

6-2 INPUT SIGNALS

6-2-1 HALT (DI 10 / – COM TERMINALS)

When you want to perform emergency stop from an external device (such as a gate-interlock system), use these terminals.

- Opening these terminals causes the CRT on the controller to display the "EMERGENCY STOP" message and the Robot will stop the motion.
- To restart Robot, it is necessary to turn off the power switch of the controller and then turn on the switch again after closing these terminals.

CAUTION:

These terminals on the I/O board have been shorted (closed) with the short bar at the factory when shipping, therefore, be sure to remove the short bar before using these terminals. See FIG. 6-2.

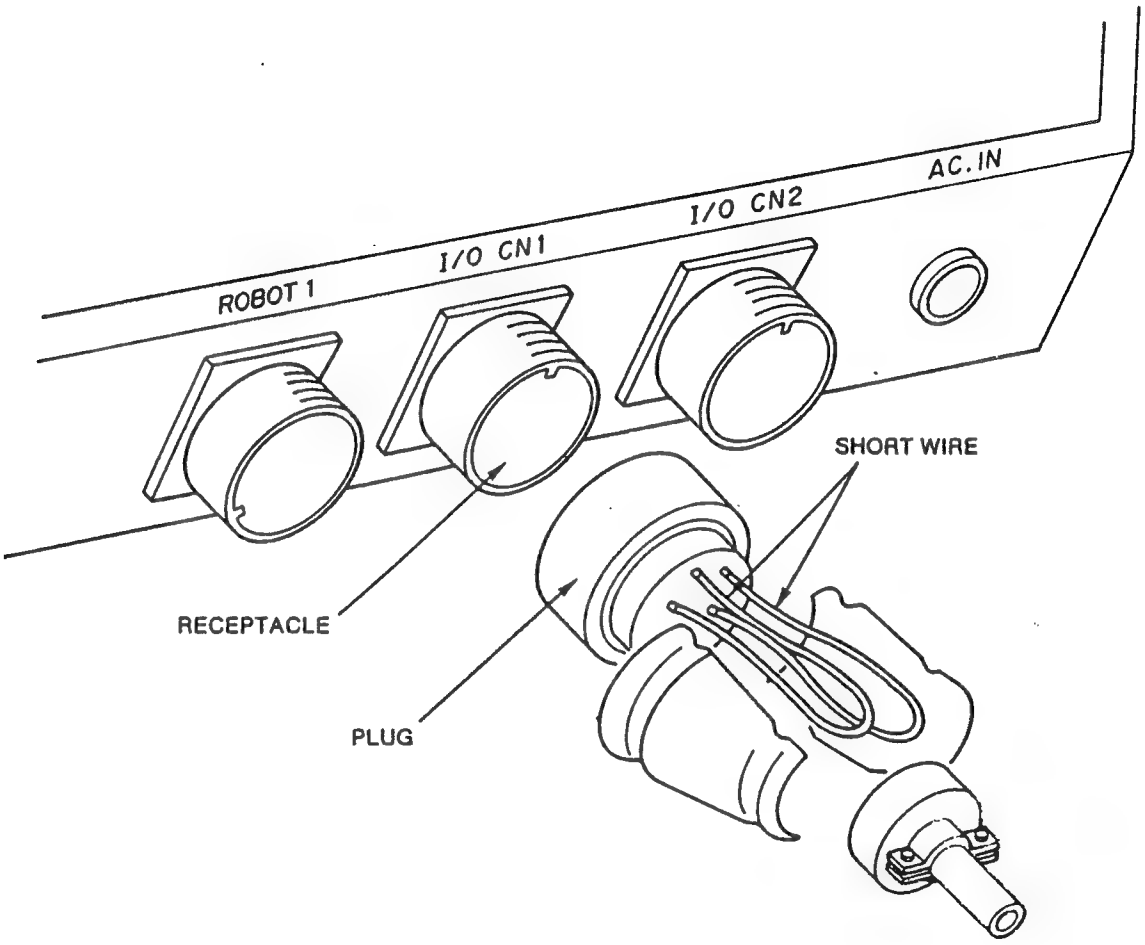


FIG. 6-2 DI 10 and DI 11 Terminals on the I/O CN 1 Plug

6-2-2 INTERLOCK (DI 11/ – COM TERMINALS)

When you want to stop the Robot temporarily during the Automatic, Semi-Automatic, Trace or Manual Mode operation, use these terminals.

- When opening these terminals (switch off) during the Robot Operation, the CRT on the controller displays the "INTERLOCK ON" message and the Robot will stop the motion temporarily.
- To start the Robot again, close (switch on) these terminals and retouch the control key which had been touched just before interlocking.

NOTE:
The DI 11 terminal has the same function as the"STOP"key.

CAUTION:

These terminals on the I/O CN 1 have been shorted (closed) with the short wire at the factory when shipping, therefore, be sure to remove the short wire before using these terminals. See FIG. 6-2.

6-2-3 RUN (DI 12/ – COM TERMINALS)

When you want to start the Robot from an external device in the Automatic, Semi-Automatic or Trace Mode, use these terminals.

- When closing these terminals (switch on), the CRT on the controller displays the "RUNNING" message and the Robot will start.

NOTE:
The DI 12 terminal has the same function as the "RUN" key.

6-2-4 AUTO (DI 13/ – COM TERMINALS)

When you want to switch the Robot operation to the Automatic Mode from an external device, use these terminals.

- When closing these terminals (switch on), the CRT on the controller displays the "AUTO" message and the Robot operation will be switched to the Automatic Mode.

NOTE:
The DI 13 terminal has the same function as the "AUTO" key.

6-2-5 RETURN TO HOME (ORIGIN) POSITION (DI 14/ – COM TERMINALS)

When you want to return the manipulator to the Home (Origin) Position from an external device, use these terminals.

- When closing these terminals (switch on), the manipulator will return to the Home (Origin) Position.

NOTE:
The DI 14 terminal has the same function as the " ⊕ " key.

6-2-6 ON/OFF CONTROL OF DO 14 TERMINAL (DI 16/ – COM TERMINALS)

When you want to turn the general purpose output DO 14 ON/OFF manually from an external device, use these terminals.

- When closing these terminals (switch on) in the Manual Mode or Program Mode, the condition of the DO 14 terminal will be switched from ON to OFF or vice versa.

NOTE:
The DI 16 terminal has the same function as the "DO 14" switch.

6-2-7 ON/OFF CONTROL OF DO 15 TERMINAL (DI 17/ – COM TERMINALS)

Similar to DI 16 terminal (6-2-6), these terminals turn the DO 15 terminal ON/OFF.

NOTE:
The DI 17 terminal has the same function as the "DO 15" switch.

6-2-8 GENERAL PURPOSE INPUTS (DI 20 ~ 27/ – COM TERMINALS)

8 of these input terminals are provided as standard equipment. These can be expanded up to a maximum of 32 terminals (DI 30 ~ DI 37, DI 40 ~ DI 47 and DI 50 ~ DI 57).

These inputs (ON/OFF signals from external push-button switches, various kinds of sensors, etc.) can be defined and used for controlling the Robot by programming. Refer to the chapter 5 "PROGRAMMING".

– MEMO –

6-3 OUTPUT SIGNALS

6-3-1 CPU OPERATION (DO 02/COM 1 TERMINALS)

When the Robot is operating normally, the DO 02 relay is on. However, in the following cases, the DO 02 relay turns off and the CPU stops, and the "EMERGENCY STOP" message appears on the screen.

- When there is something wrong with the CPU.
- When the motor driver has detected a malfunction.
- When the arm has reached the 2nd travel limit.
- When the emergency stop switch (red button) on the teach pendant is pushed.
- When the DI 10 and −COM terminals are opened (off).

6-3-2 OPERATION MODE (DO 03/COM 1 TERMINALS)

When the Robot is the Operation Mode (Automatic, Semi-Automatic, or Trace Mode), the DO 03 relay is on.

6-3-3 OPERATING (DO 04/COM 1 TERMINALS)

When a user program is being run in the Operation Mode, the DO 04 relay is on and the "RUNNING" message appears on the screen.

6-3-4 RETURN TO HOME (ORIGIN) POSITION COMPLETION (DO 05/COM 1 TERMINALS)

When the return to Home (Origin) position procedure is completed after turning on the power switch, the DO 05 relay is on.

6-3-5 1ST/2ND ARMS (X/Y AXES) HOME (ORIGIN) POSITION (DO 06/COM 2 TERMINALS)

When the proximity switches for the Home (Origin) positions of the 1st arm (X-axis) and 2nd arm (Y-axis) are both activated, the DO 06 relay is on. This relay turns off when either of the arms move away from their Home (Origin) positions.

6-3-6 3RD JOINT (Z-AXIS) HOME (ORIGIN) POSITION (DO 07/COM 2 TERMINALS)

This terminal is similar to the DO 06 terminal.
When the 3rd joint (Z-axis) is in its Home (Origin) position, the DO 07 relay is on.

6-3-7 GENERAL PURPOSE OUTPUTS (DO 10~17/−COM TERMINALS)

These DO 10~17 terminals are equipped as a standard.

These terminals can be expanded up to 24 terminals (DO 20~27 and DO 30~37) by adding the optional terminals.

These terminals (except DO 16 and 17 terminals) can be used almost any desired manner within a user program and the DO 14 and 15 in these terminals can be turned ON/OFF by the "DO 14" and "DO 15" switches on the controller panel or by the DI 16 and DI 17 terminals.

- When the 3rd joint (Z-axis, air cylinder type) is installed, the DO 16 terminal can be turned ON/OFF by the "Z+" and "Z−" keys in the Manual Mode and Program Mode.
- When the DO 16 is ON, the "1" appears in the 3rd joint (Z-axis) part of the arms and joints current position display on the bottom of the screen.
  In the Operation Modes, it turns ON/OFF according to an "OUT" command as well. However, it can also be turned ON or OFF by inputting "1" or "0" as the 3rd joint (Z-axis) point data and by performing the "MOV" command in the program.

  NOTE:
  It can only be performed with the values "1" or "0".

- The following example programs A and B are equivalent because each program shows the DO 16 terminal out-signal is output after the 1st/2nd arms (X/Y axes) and optional joints (Z and/or R axes) moved into the out-signal output position (refer to 7-4 in Chapter 7 "ROBOT ADJUSTEMENT").

```
PROGRAM A:  MOV  50000  20000  1  5000
PROGRAM B:  MOV  50000  20000  0  5000
            OUT #1 BIT 6=1B
```

  NOTE:
  It is very effective to use the DO 16 terminal as the output for driving a solenoid valve when the 3rd joint (Z-axis, air cylinder type) is installed.

- The DO 17 terminal is exactly same function for the 4th joint (R-axis) as the DO 16 for the 3rd joint (Z-axis).

  NOTE:
  It is very effective to use the DO 17 terminal as the output for driving a gripper etc.

- When the 3rd joint (Z-axis, motor type) and 4th joint (R-axis, motor type) have been installed, the DO 16 and 17 terminals become just general purpose outputs.

  NOTE:
  The DO 10~17 terminals are the switching transistor (NPN open collector) outputs.

6-4 INPUT/OUTPUT CONNECTION

6-4-1 CONNECTOR

All user input/output terminals are wired to the input/output connectors I/O CN 1 and I/O CN 2 on the lower part of the controller. When making connections, use the supplied plugs.

Connector Designation	I/O CN 1	I/O CN 2
Compatible canon plug Cable clamp Maker name	MS3106B-32A10P MS3057-20A	←
Number of pins	54	←
Note	Standard	Option

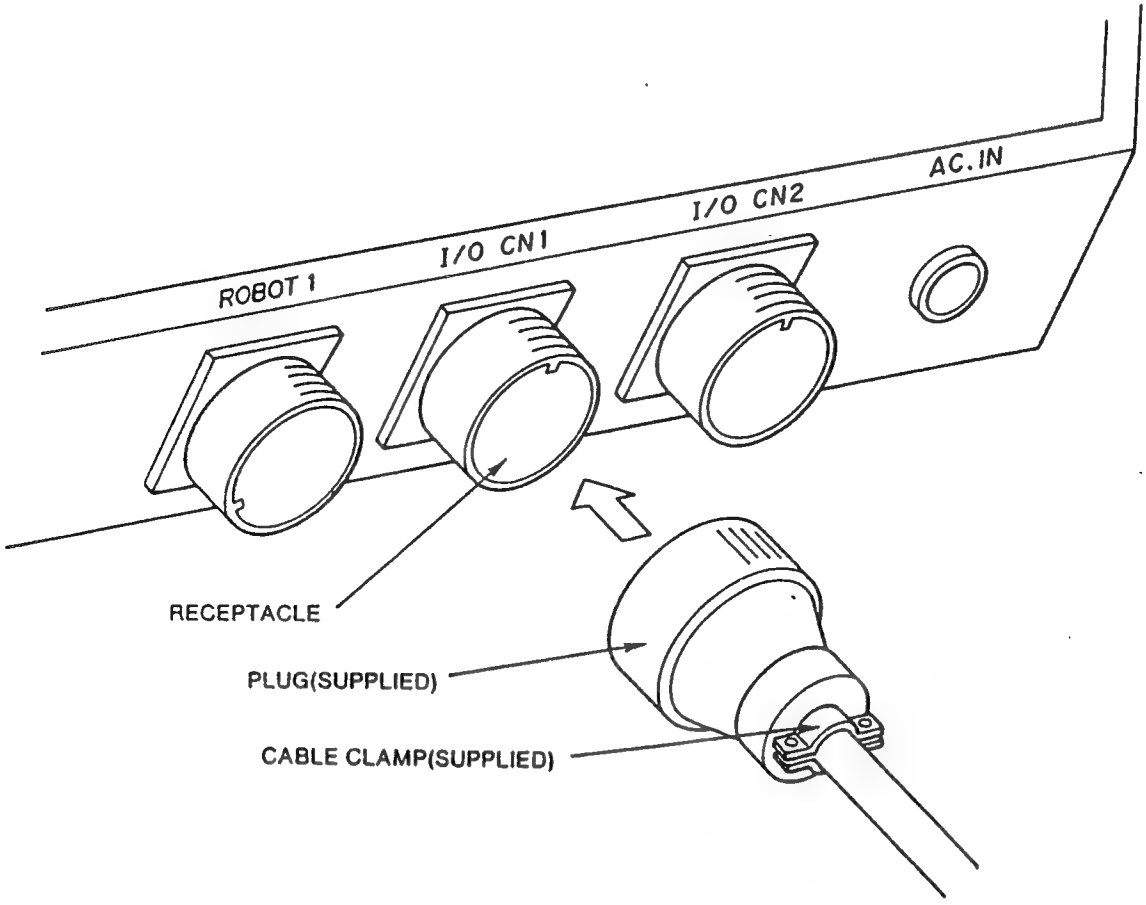


FIG. 6-3 I/O Connection

6-4-2 CONNECTER PIN AND I/O NO RELATION TABLE

6-4-2-1 I/O CN 1 (STANDARD)

PIN	I/O NO.	SIGNAL	REMARKS
A	DI 10	Halt	NOTE1
B	DI 11	Interlock	NOTE 1
C	DI 12	RUN Input	
D	DI 13	AUTO Input	
E	DI 14	ORIGIN Input	
F	DI 15	Reserve	
G	DI 16	DO14 ON/OFF	
H	DI 17	DO15 ON/OFF	
J	DI 20	GENERAL PURPOSE INPUT 20	
K	DI 21	GENERAL PURPOSE INPUT 21	
L	DI 22	GENERAL PURPOSE INPUT 22	
M	DI 23	GENERAL PURPOSE INPUT 23	
N	DI 24	GENERAL PURPOSE INPUT 24	
O	DI 25	GENERAL PURPOSE INPUT 25	
P	DI 26	GENERAL PURPOSE INPUT 26	
R	DI 27	GENERAL PURPOSE INPUT 27	
S	–	NON CONNECTION	
T	–	NON CONNECTION	
U	–	NON CONNECTION	
V	–	NON CONNECTION	
W	–	NON CONNECTION	
X	–	NON CONNECTION	
Y	–	NON CONNECTION	
Z	–	NON CONNECTION	
a	+COM	DC 24 volt	
b	+COM	DC 24 volt	
c	−COM	0 volt	
d	−COM	0 volt	
e	−COM	0 volt	
f	COM 1	COM 1	
g	DO 02	CPU OK	
h	DO 03	Operation mode	
j	DO 04	Operating	
k	DO 05	Return to Home (Origin) Position is completed	
m	COM 2	COM 2	
n	DO 06	X/Y axes Home Position	
p	DO 07	Z axis Home Position	
q	–	NON CONNECTION	
r	–	NON CONNECTION	
s	–	NON CONNECTION	
t	DO 10	GENERAL PURPOSE OUTPUT 10	NOTE 2
u	DO 11	GENERAL PURPOSE OUTPUT 11	NOTE 2
v	DO 12	GENERAL PURPOSE OUTPUT 12	NOTE 2
w	DO 13	GENERAL PURPOSE OUTPUT 13	NOTE 2
x		NON CONNECT	
y	DO 14	GENERAL PURPOSE OUTPUT 14	NOTE 2
z	DO 15	GENERAL PURPOSE OUTPUT 15	NOTE 2

AA	DO 16	GENERAL PURPOSE OUTPUT 16 Z ON/OFF	NOTES 2 AND 3
AB	DO 17	GENERAL PURPOSE OUTPUT 17 R ON/OFF	NOTES 2 AND 3
AC	+COM	DC 24 volt	
AD	+COM	DC 24 volt	
AE	-COM	0 volt	
AF	−COM	0 volt	
AG	E	Ground	

NOTE:

1 DI 10, 11 are used in normally closed, all other DI in normally open.

2 DO 10 ~ 17 are switching transistor (NPN open collector) outputs, all other DO are 2-point or 4-point common relay outputs.

3 See general purpose outputs.

6-4-2-2 I/O CN 2 (OPTION)

PIN	I/O NO.	SIGNAL	REMARKS
A	DI 30	GENERAL PURPOSE INPUT 30	
B	DI 31	GENERAL PURPOSE INPUT 31	
C	DI 32	GENERAL PURPOSE INPUT 32	
D	DI 33	GENERAL PURPOSE INPUT 33	
E	DI 34	GENERAL PURPOSE INPUT 34	
F	DI 35	GENERAL PURPOSE INPUT 35	
G	DI 36	GENERAL PURPOSE INPUT 36	
H	DI 37	GENERAL PURPOSE INPUT 37	
J	DI 40	GENERAL PURPOSE INPUT 40	
K	DI 41	GENERAL PURPOSE INPUT 41	
L	DI 42	GENERAL PURPOSE INPUT 42	
M	DI 43	GENERAL PURPOSE INPUT 43	
N	DI 44	GENERAL PURPOSE INPUT 44	
O	DI 45	GENERAL PURPOSE INPUT 45	
P	DI 46	GENERAL PURPOSE INPUT 46	
R	DI 47	GENERAL PURPOSE INPUT 47	
S	DI 50	GENERAL PURPOSE INPUT 50	
T	DI 51	GENERAL PURPOSE INPUT 51	
U	DI 52	GENERAL PURPOSE INPUT 52	
V	DI 53	GENERAL PURPOSE INPUT 53	
W	DI 54	GENERAL PURPOSE INPUT 54	
X	DI 55	GENERAL PURPOSE INPUT 55	
Y	DI 56	GENERAL PURPOSE INPUT 56	
Z	DI 57	GENERAL PURPOSE INPUT 57	
a	+COM	DC 24 volt	
b	+COM	DC 24 volt	
c	−COM	0 volt	
d	−COM	0 volt	
e	−COM	0 volt	
f	COM 4	COM 4	
g	DO 20	GENERAL PURPOSE OUTPUT 20	/ COM 4
h	DO 21	GENERAL PURPOSE OUTPUT 21	/ COM 4
j	DO 22	GENERAL PURPOSE OUTPUT 22	/ COM 4
k	DO 23	GENERAL PURPOSE OUTPUT 23	/ COM 4
m	COM 5	COM 5	
n	DO 24	GENERAL PURPOSE OUTPUT 24	/ COM 5
p	DO 25	GENERAL PURPOSE OUTPUT 25	/ COM 5
q	DO 26	GENERAL PURPOSE OUTPUT 26	/ COM 5
r	DO 27	GENERAL PURPOSE OUTPUT 27	/ COM 5
s	COM 6	COM 6	
t	DO 30	GENERAL PURPOSE OUTPUT 30	/ COM 6
u	DO 31	GENERAL PURPOSE OUTPUT 31	/ COM 6
v	DO 32	GENERAL PURPOSE OUTPUT 32	/ COM 6
w	DO 33	GENERAL PURPOSE OUTPUT 33	/ COM 6
x	COM 7	COM 7	
y	DO 34	GENERAL PURPOSE OUTPUT 34	/ COM 7
z	DO 35	GENERAL PURPOSE OUTPUT 35	/ COM 7
AA	DO 36	GENERAL PURPOSE OUTPUT 36	/ COM 7
AB	DO 37	GENERAL PURPOSE OUTPUT 37	/ COM 7
AC	+COM	DC 24 volt	
AD	+COM	DC 24 volt	
AE	−COM	0 volt	
AF	−COM	0 volt	

6-4-3 INPUT/OUTPUT CONNECTION EXAMPLE

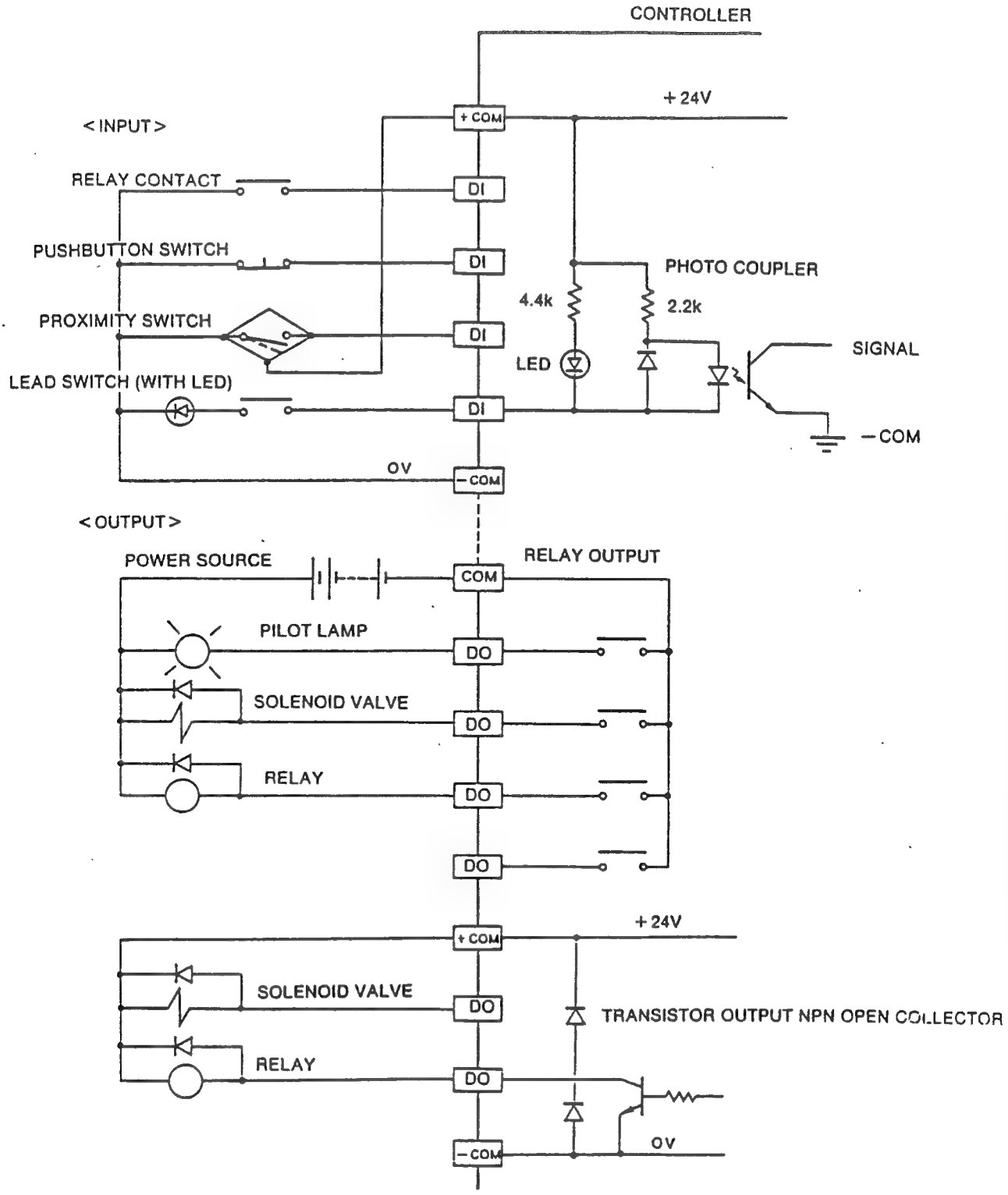


FIG. 6-4 Input/Output Connection Example

NOTE:
All inputs/outputs are isolated from the controller by the photo coupler.

6-4-4 I/O SPECIFICATION

a. Input: Contact Input
b. Output: Relay Output: AC 110V 0.5A (Ohmic Load)
DC 24V 1A (Ohmic Load)
Transistor Output: DC 24V 0.5A (Ohmic Load)
c. DC Power source: +24V smoothed output Max. 2A

CAUTION:

When connecting solenoid valves and relays to the output terminals, be sure to connect a surge suppression diode in parallel with the load.
Do not supply more than 24V, 2A to the DC power source. It may cause a faulty operation.

6-5 INPUT/OUTPUT OPERATION MONITOR

The on/off condition of the robot inputs/outputs can be monitored by watchig the LEDs on the I/O monitor on the back of the controller door.

When the LEDs are lit, the corresponding DI/DO is on.

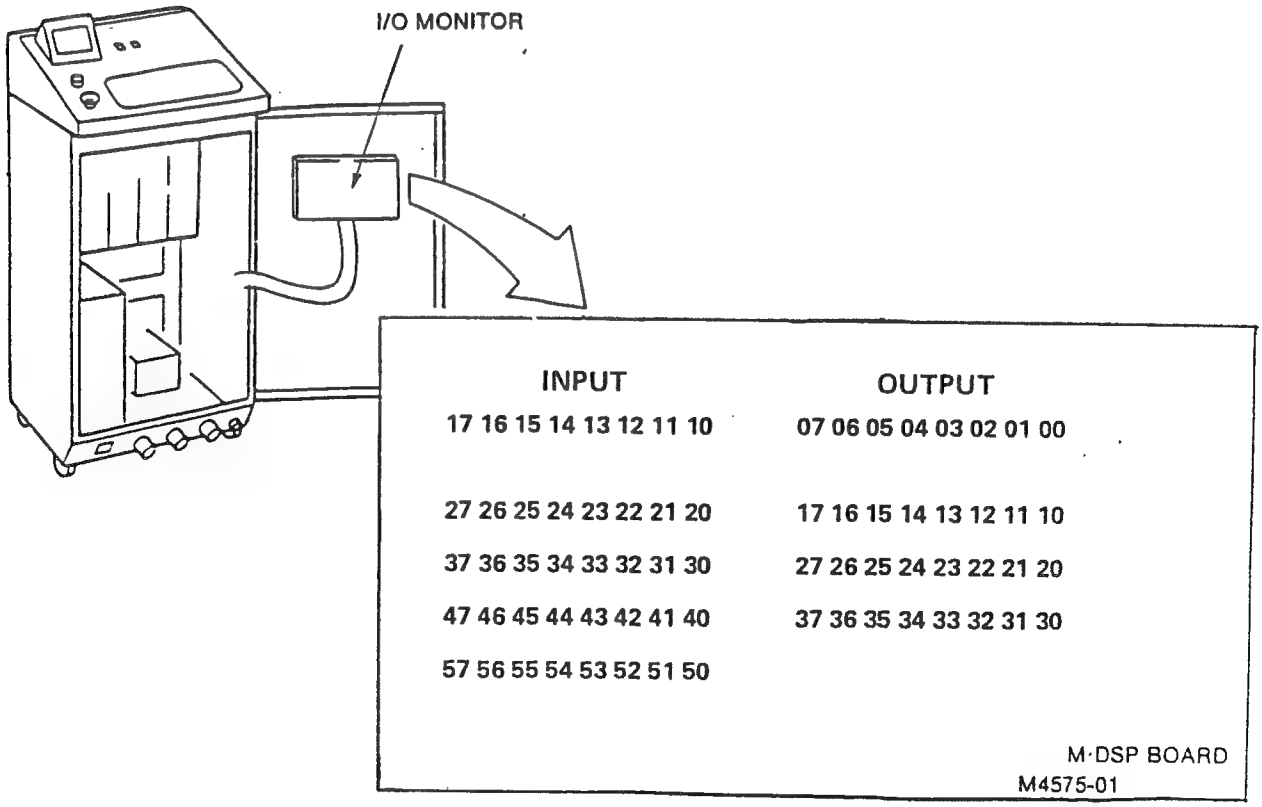


FIG. 6-5. LED Locations on I/O Monitor

CHAPTER 7
ROBOT ADJUSTMENTS

CHAPTER 7
ROBOT ADJUSTMENT

7-1 DESCRIPTION

The 2nd limit switch position and other various adjustments for the Maker Robot have been adjusted completely by the factory or distributor at the time of the shipping. However, those adjustments (see FIG. 7-1) can be altered to meet user's working requirements. If necessary, proceed as follows.

NOTE:
When readjustments are necessary, they should be performed after understanding the following procedures thoroughly.

WARNING:

Turn the power switch off when making internal adjustments to the Robot to prevent an accident from an electrical shock and/or an unexpected Robot movement.

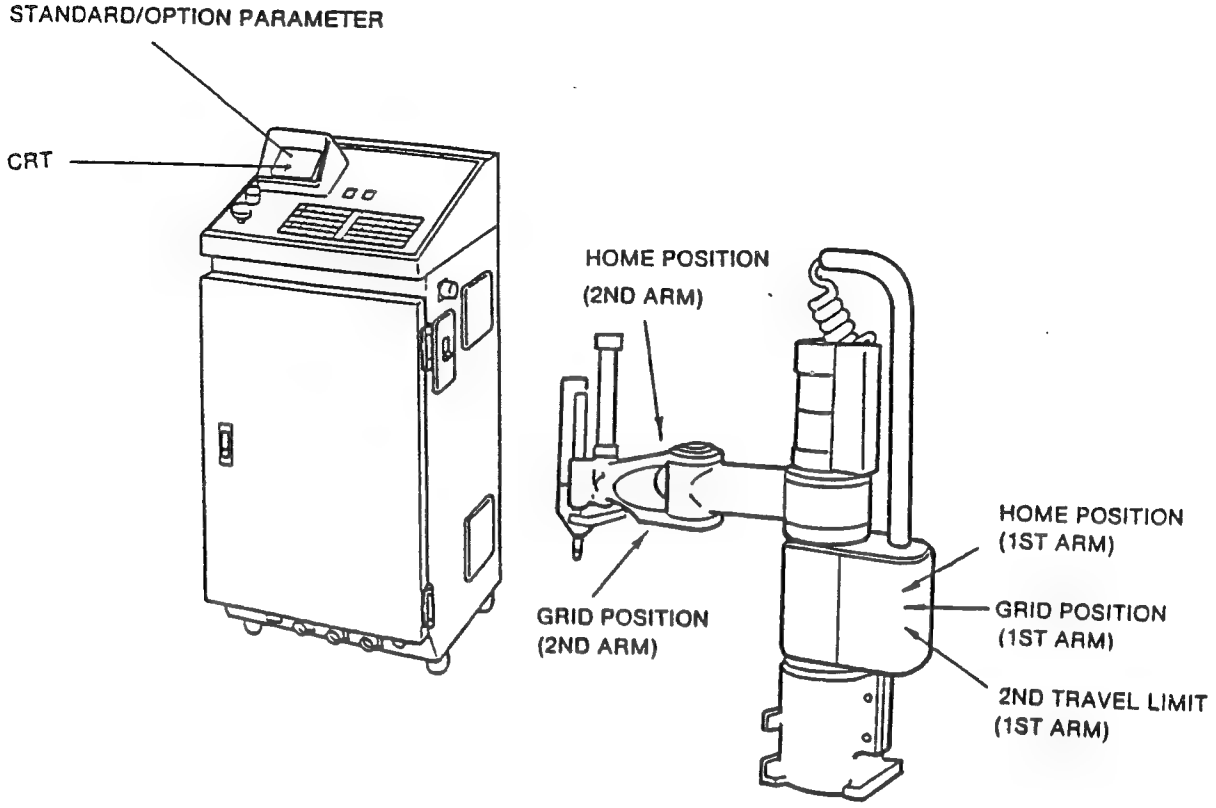


FIG. 7-1 Adjustments

7-2 ADJUSTMENT OF HOME (ORIGIN) POSITION AND 2ND LIMIT DOG

The Home (Origin) Position and 2nd travel limit will be set at where each proximity switch detects each related dog.

These Home (Origin) Position and 2nd travel limit can be shifted by shifting each dog position.

NOTE:

- **The proximity switches can not be moved as they have been fixed to the arm and main body.**
- **The 1st travel limit (soft limit) can be shifted by altering the parameter value (refer to 7-4 "PARAMETER ADJUSTMENT" in this chapter).**
- **The Home (Origin) position and 2nd travel limits of the optional 3rd and 4th joints (Z and R axes) are not adjustable.**

7-2-1 LOCATION OF PROXIMITY SWITCH AND DOG

The following switches and dogs are built into the 1st and 2nd joints.

• Home (Origin) Position:	Proximity switch	1pc.
	Dog	1pc.
• 2nd travel limit:	Proximity switch	1pc.
	Dog	2pcs.

The locations of these proximity switches and dogs are as shown.

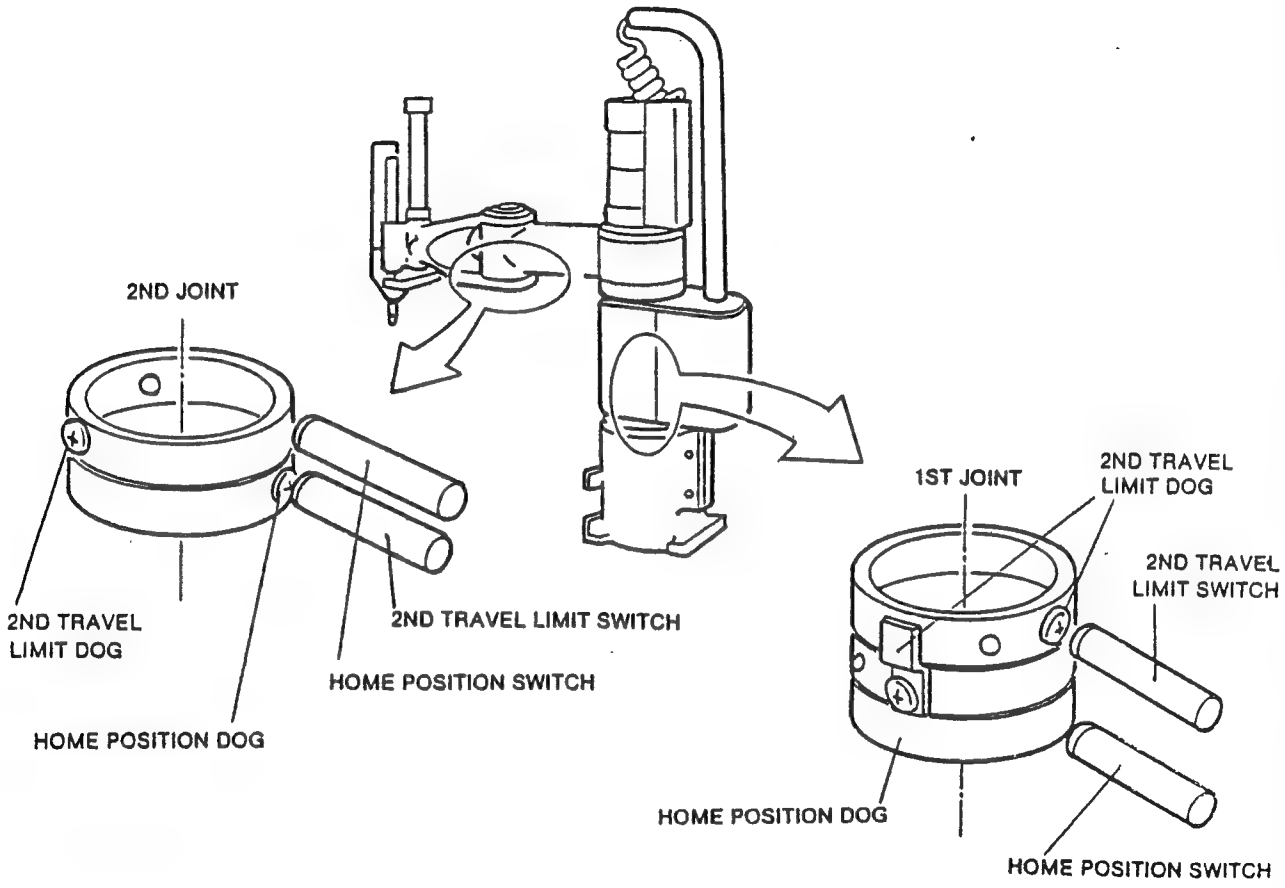


FIG. 7-2 Proximity Switch and Dog Location

7-2-2 HOME (ORIGIN) POSITION

When the return to Home (Origin) Position key ("MM") is touched, the 1st arm (X-axis) begins to move in the "−" direction and stops when the controller receives first encoder zero signal just after the dog aligned with the proximity switch, then the 2nd arm (Y-axis) moves same way.

The Home (Origin) Position of this Robot has been adjusted as shown in FIG. 7-3 by the factory or distributor at the time of shipping.

NOTE:

- **The order of the return to Home (Origin) positions of each arm can be selected by selecting the value (0 or 1) of the standard parameter No.16 (refer to Chapter 7 "ROBOT ADJUSTMENT").**
- **If optional 3rd and/or 4th joints (Z and/or R axes, motor type) are installed,the return to Home (Origin) Position of each joint are performed as follows:**
  3rd Joint ....This joint is performed first (before 1st and 2nd arms).
  4th Joint ....After completing the 1st and 2nd arms.

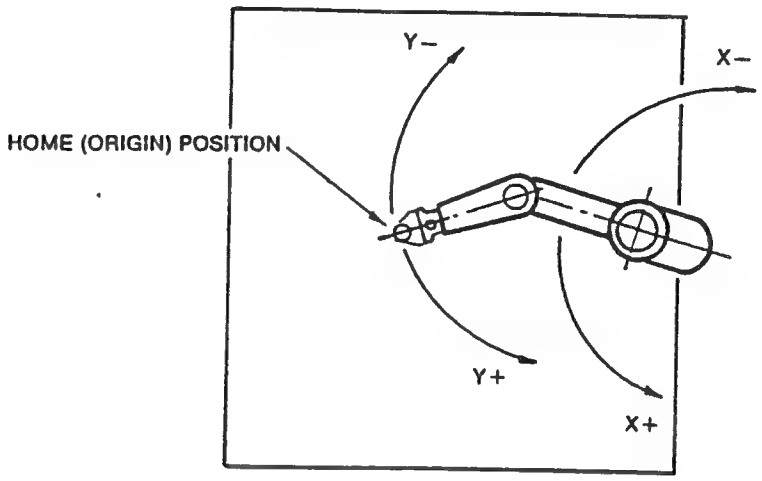


FIG. 7-3 The Standard Home Position and Direction

7-2-3 GRID POSITION

When the return to Home (Origin) Position has been completed, the pulse numbers of each Grid Position are displayed on the screen. Each Grid Position shows the distance between the zero signal and the Home (Origin) Position limit in the number of the encoder pulses as shown in FIG. 7-4.

The numbers of the Grid Position must be adjusted within the specifications in order to keep the Robot's repeatability.

NOTE:

- **The Grid Position may very somewhat depending on the operation timing of the proximity switch.**
- **The Grid Positions of the optional 3rd and 4th joints (Z and R axes) are not adjustable.**

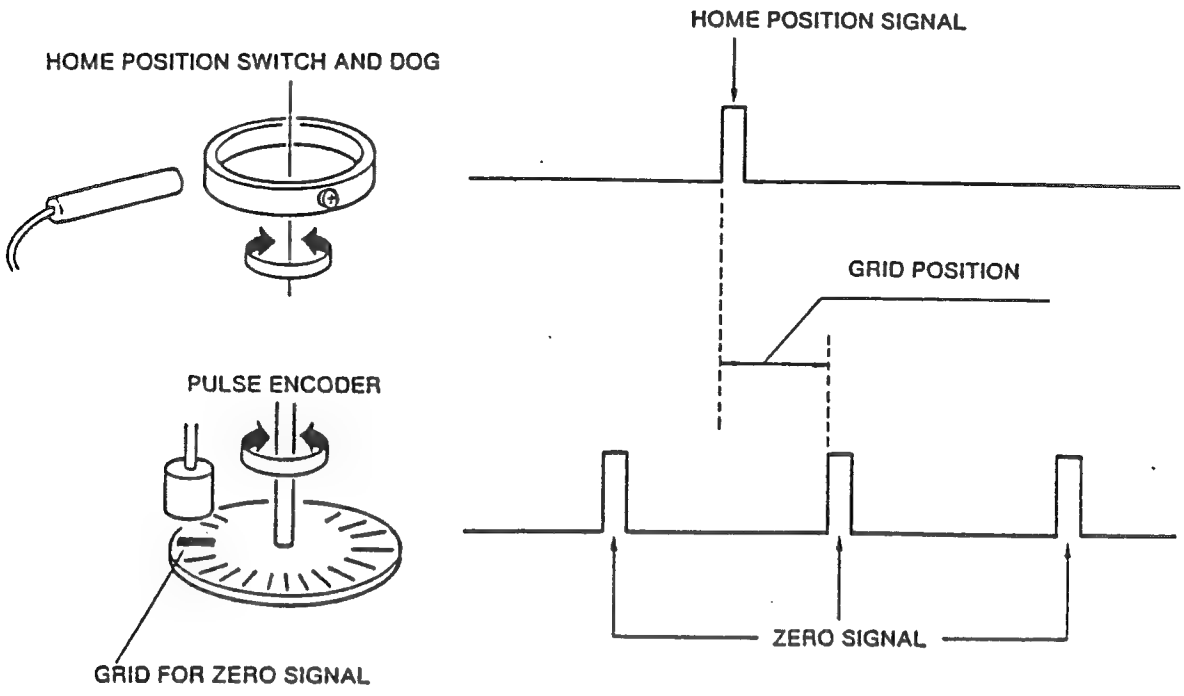


FIG. 7-4 Grid Position

7-2-4 RELATION BETWEEN LIMIT SWITCH AND DOG

The relations between limit switches and dogs are as shown.

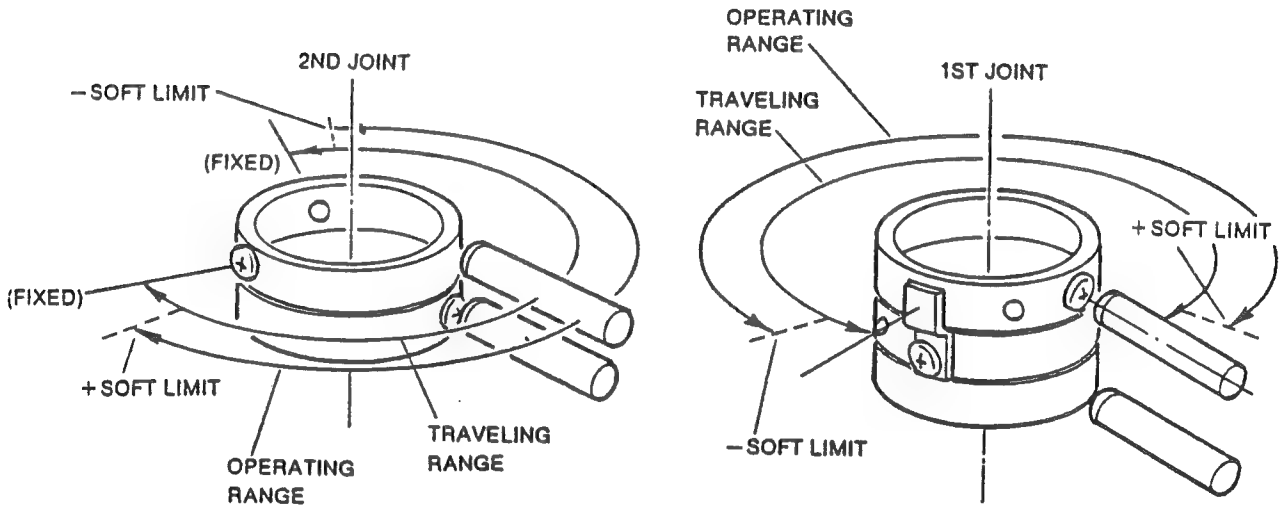


FIG. 7-5 Relation Between Limit Switch and Dog

a. When the arm reaches the second travel limit and turns the second limit switch on, the "SECOND LIMIT OVER" message will appear on the screen and the motor powers are turned off.

   To restart the Robot:

   1) Turn off the power switch.

   2) Bring the Robot arm into the normal operating range by hands.

   3) Turn on the power swich and restart the Robot by following the operation procedures in Chapter 4 "OPERATION".

b. When the arm reaches the first travel limit, the "SOFT LIMIT OVER" message will appear on the screen and the contollor stops the arm movement.

   To restart the Robot:

   1) Select the Manual Mode.

   2) Bring the Robot arm into the normal operating range by using the manual arm operation keys.

   WARNING:

   When the arm movement is stopped with the "SOFT LIMIT OVER" message on the screen, never enter the Robot working area.

   3) Restart the Robot by following the operation procedures in Chapter 4 "OPERATION".

7-2-5 ADJUSTMENT OF X-AXIS HOME (ORIGIN) POSITION DOG

1) Perform the Return to Home (Origin) Position.
2) Turn the power switch off.
3) Remove the backcover of the Robot body.

   The Home (Origin) Position dog and its setscrew will appear at the center of the square window as following FIG. 7-6.

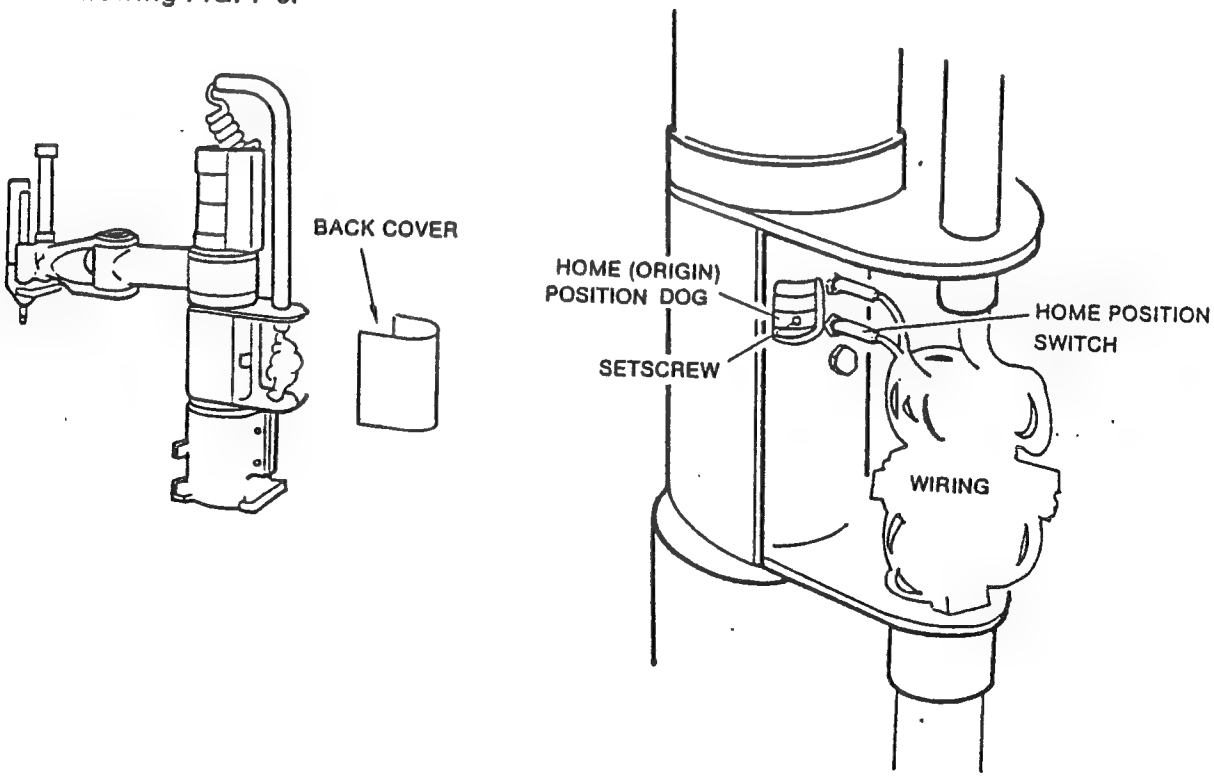


FIG. 7-6 Home Position Dog of X-axis

4) Loosen the setscrew of the dog by using a 2 mm hex wrench.
5) Move the 1st arm (X-axis) to the desired Home (Origin) Position by hands.
6) Rotate the dog so that the setscrew appears at the center of the window.
   Then the dog is just aligned with the proximity switch of the Home (Origin) Position.
7) Tighten the setscrew.
8) Turn the power switch on and perform the Return to Home (Origin) Position.

9) Check the number of the Grid position display on the screen.

- If they are within the following specification, the adjustment is complete.
- If not, readjust the dog by rotating slightly clockwise or counterclockwise (fine adjustment) until the number is within the specification.

GRID POSITION
X/Y AXES: −2000 ±400 pulses

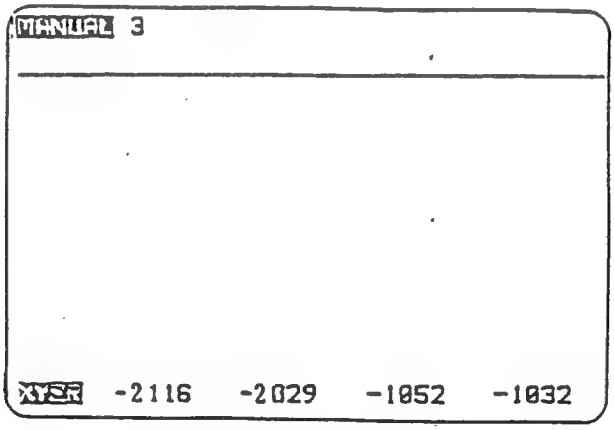


FIG. 7-7 Grid Position Display

10) Reinstall the backcover.

7-2-6 ADJUSTMENT OF X-AXIS 2ND LIMIT DOG

1) Move the Robot arm to the 2nd travel limit position of " + " direction in the Manual Mode, and the Robot stops in "EMERGENCY STOP".

2) Turn the power switch off.

3) Remove the backcover of the Robot body.
The 2nd limit dog and the setscrew (for " + " direction) will appear at the center of the square window as following FIG. 7-8.

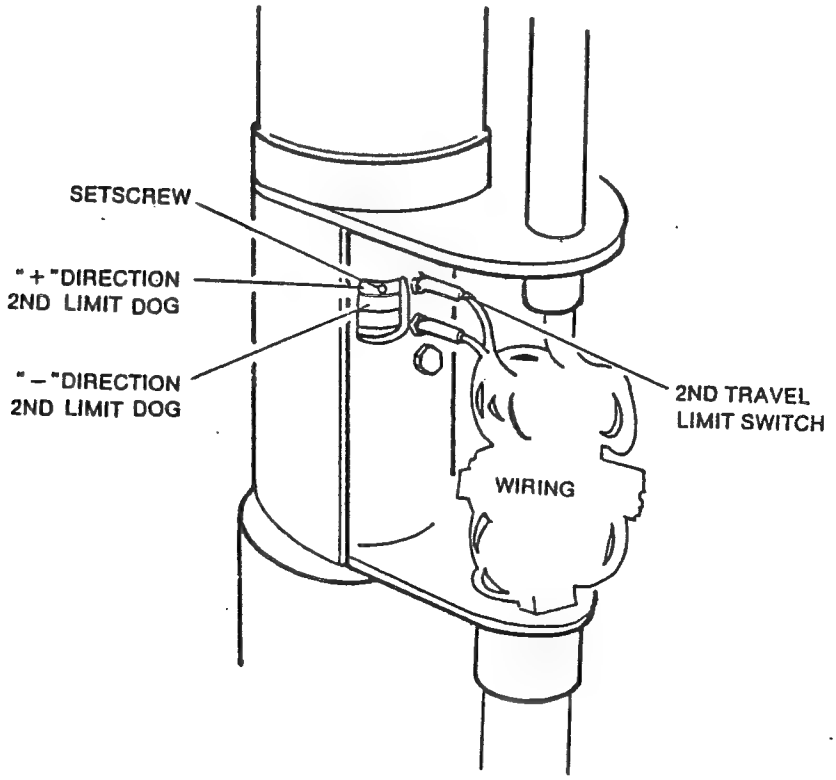


FIG. 7-8 2nd Limit Dog of X-axis

4) Loosen the setscrew of the dog by using a 2 mm hex wrench.

5) Move the 1st arm (X-axis) to the desired 2nd travel limit (" + " direction) by hands.

6) Rotate the dog so that the setscrew appears at the center of the window.
Then the dog is just aligned with the proximity switch of the " + " direction 2nd travel limit.

7) Tighten the setscrew. The adjustment of " + " direction 2nd travel limit is complete.

8) For " − " direction 2nd travel limit, perform the same way as above procedure.

9) After completing the adjustment, reinstall the backcover.

7-2-7 ADJUSTMENT OF Y-AXIS HOMR (ORIGIN) POSITION DOG

1) Perform the Return to Home (Origin) Position.

2) Turn the power switch off.

3) Remove the black rubber cap.
The Home (Origin) Position dog and its setscrew will appear through the hole.

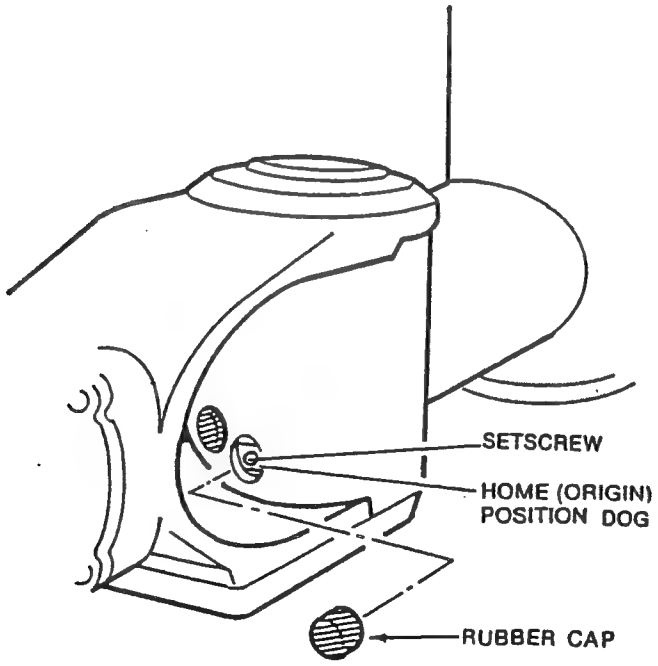


FIG. 7-9 Home Position Dog of Y-axis

4) Loosen the setscrew of the dog by using a 2 mm hex wrench.

5) Move the 2nd arm (Y-axis) to the desired Home (Origin) Position by hands.

6) Rotate the dog so that the setscrew appears through the hole.
Then the dog is just aligned with the proximity switch of the Home (Origin) Position.

7) ~ 9) Same as the adjustment of X-axis.

10) Reinstall the rubber cap.

7-3 Y-AXIS 2ND TRAVEL LIMIT

The 2nd travel limits of the 2nd arm (Y-axis) have been adjusted and fixed as shown in FIG. 7-10 by the factory.

NOTE:
The 2nd travel limits of the 2nd arm (Y-axis) are not adjustable.

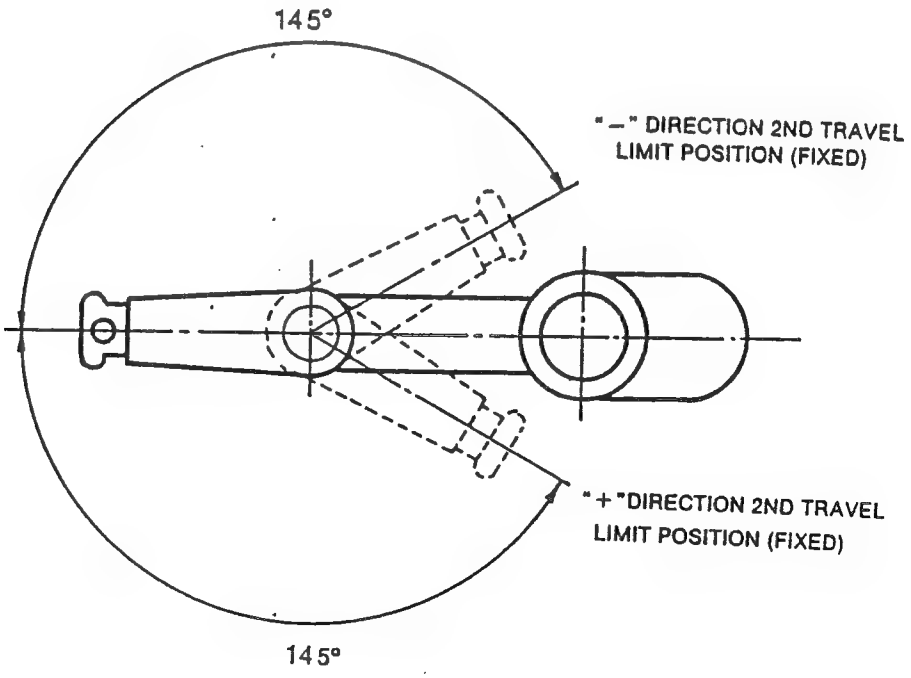


FIG. 7-10 2nd Travel Limits of Y-axis

7-4 PARAMETER ADJUSTMENT

7-4-1 TYPE OF PARAMETER

There are two types of parameters;

a. standard parameters for the standard model.

b. option parameters for optional equipment.

By using (setting) these parameters, you can operate the Robot under the most suitable conditions for your requirements.

WARNING:

In order to operate the Robot safely and efficiently, it is necessary to set various parameters corresponding to the conditions under which the Robot is used.

– MEMO –

7-4-1-1 STANDARD PARAMETER TABLE

NO.	PARAMETER NAME	INITIAL SETTING	AVAILABLE RANGE OF SETTING PARAMETER
1.	X,Y JOG SPEED	300	1~400
2.	X,Y TPB INCHING	40	1~200
3.	X,Y TPB HIGH SPEED	40	1~100
4.	X PTP SPEED	2000	1~2000
5.	Y PTP SPEED	2000	1~2000
6.	X,Y CP SPEED	240	1~240
7.	–	–	–
8.	–	–	–
9.	–	–	–
10.	–	–	–
11.	X TOLERANCE	4	1~1000
12.	Y TOLERANCE	4	1~1000
13.	XY OUT POSITION	500	1~30000
14.	–	–	–
15.	–	–	–
16.	TO ORIGIN SEQ.	0	0 or 1
17.	TIP WEIGHT	10	0~20
18.	X, Y ACCELERATION	100	1~100
19.	–	–	–
20.	–	–	–
21.	X + SOFT LIMIT	160000	−240000~240000
22.	X − SOFT LIMIT	−160000	−240000~240000
23.	Y + SOFT LIMIT	160000	−240000~240000
24.	Y − SOFT LIMIT	−160000	−240000~240000
25.	X ORIGIN SHIFT	0	−160000~160000
26.	Y ORIGIN SHIFT	0	−160000~160000
27.	–	–	–
28.	–	–	–
29.	X ARM LENGTH	25000	1~50000
30.	Y ARM LENGTH	25000	1~50000

7-4-1-2 OPTION PARAMETER TABLE

NO.	PARAMETER NAME	INITIAL SETTING	AVAILABLE RANGE OF SETTING PARAMETER
1.	R. JOG SPEED	400	1~400
2.	R. TPB SPEED	40	1~200
3.	R. PTP SPEED	2000	1~2000
4.	–	–	–
5.	–	–	–
6.	R. TOLERANCE	8	1~1000
7.	R. OUT POSITION	100	1~30000
8.	R ACCELERATION	100	1~100
9.	–	–	–
10.	R. RETENTION	0	0 or 1
11.	Z JOG SPEED	300	1~300
12.	Z TPB SPEED	40	1~200
13.	Z PTP SPEED	2000	1~2000
14.	–	–	–
15.	–	–	–
16.	Z TOLERANCE	8	1~1000
17.	Z OUT POSITION	500	1~30000
18.	Z ACCELERATION	100	1~100
19.	–	–	–
20.	–	–	–
21.	Z + SOFT LIMIT	75000	−75000~75000
22.	Z − SOFT LIMIT −2000	−75000	−75000~75000
23.	R + SOFT LIMIT	50000	−400000~400000
24.	R − SOFT LIMIT	−50000	−400000~400000
25.	Z ORIGIN SHIFT	0	−75000~75000
26.	R OFFSET PULSE	0	−50000~50000
27.	–	–	–
28.	–	–	–
29.	–	–	–
30.	–	–	–

7-4-2 MEANING AND ADJUSTMENT OF PARAMETER

7-4-2-1 STANDARD PARAMETERS

No.1: XY JOG SPEED (manual speed in r.p.m.)

This parameter sets the motor speed of the arm movement in the Manual Mode.

The speed settings 1,2 and 3 in the Manual Mode show the percentage of this parameter.

1: 100%,	2: 50%,	3: 25%

EX. When the parameter setting is "300" and the speed setting is "3", the motor speed in Manual Mode is

$$300 \times 0.25 = 75 \text{ r.p.m.}$$

No.2: XY TPB INCHING (teach inching distance in pulses)

This parameter sets the distance of inching in the Program Mode.

The speed setting 1,2, and 3 during teaching show the percentage of this parameter.

1: 100%,	2: 25%,	3: 6.25%

EX. When the parameter setting is "200" and the motor speed setting is "2", the inching is performed at

$$200 \times 0.25 = 50 \text{ pulses.}$$

No.3: XY TPB HIGH SPEED (moving speed in r.p.m.)

When teaching in the Program Mode or Point Data Mode, the high-speed orthogonal movement can be performed by touching the "~" or "SPEED" key while touching the keys for moving the 1st and 2nd arms (X and Y axes).

This speed is detemined by this parameter.

No.4: X PTP SPEED (point to point speed in r.p.m.)

No.5: Y PTP SPEED (point to point speed in r.p.m.)

These parameters (Nos. 4 and 5) set the maximum speed for each arm in the Automatic, Semi-Automatic and Trace Modes for P.T.P. (Point to Point) control.

The speed settings 1,2, and 3 in the Automatic, Semi-Automatic and Trace Modes show the parcentage of this parameter.

1: 100%,	2: 70%,	3: 50%

EX. When the parameter settings are "2,000" and the speed settings are 1, the maximum speed for P.T.P. control are

$$2{,}000 \times 1.00 = 2{,}000 \text{ r.p.m.}$$

NOTE:

- **The conditions for achieving maximum speed in P.T.P. vary according to the moving distance and the weight parameter No.17.**
- **When the speed is specified by "VEL" (velocity) command in the user program during the "MOV" (P.T.P) command, speed drops to the value (percentage) specified after VEL.**

No.6: X Y CP SPEED (continuous path speed in r.p.m.)

This parameter sets the speed for CP (continuous path) control.
The speed settings 1,2, and 3 show the percentage of this parameter.

1: 100%,	2: 50%,	3: 25%

NOTE:
The speed can be set by VEL during the CP command performed.

EX. When the parameter setting is "120", speed setting is "2", and VEL is "60(%)", the CP control speed is

$$120 \times 0.5 \times 0.6 = 36 \text{ r.p.m.}$$

No.7: DATA BIT

The required bit numbers for one word.

No.8: PARITY

For setting the check bit of the data checking.
The check bit settings are performed by 0, 1, and 2 as follows:

0: Not set, 1: Set for odd, 2: Set for even

No.9: STOP

The stop bit for the one data end.

No.10: BAUD RATE

For setting the data transmitting speed.

No.11: X TOLERANCE (in pulses)

No.12: Y TOLERANCE (in pulses)

These parameters (Nos. 11 and 12) set each tolerance range for the 1st and 2nd arms (X and Y axes) positionings.

When the arms are positioned within each tolerance range, the Robot can be performed the next one line of the command in the user program.

No.13: XY OUT POSITION (out effective position in pulses)

If an output is to be activated before positioning of the 1st and 2nd arms (X and Y axes) is completed (before the 1st and 2nd arms are positioned within the tolerances), this parameter determines how many pulses before the target position are set as the out-signal position.

When this value is within the tolerance range, the out-signal is output when the arms enter each tolerance range.

EX. Point A X = 50,000 Y = 30,000
Point B X = 20,000 Y = 60,000

You want to move the arms from A to B.

1) If the parameter No.11 is "8", No.12 is "12", and No.13 is "6", the out-signal is output when

X < 20,007, Y > 59,989

2) If the parameter No.11 is "8", No.12 is "12", and No.13 is "500", the out-signal is output when

X < 20,449, Y > 59,501

Note that though the out-signal is output, the positioning continues until the arms enter each tolerance range (parameter Nos. 11 and 12).

Nos.14 and 15: Not used.

No.16: TO ORIGIN SEQ (order of return to the Home Position)

This parameter determines the order in which the Return To Home (Origin) Position is performed.

1) When the parameter setting is "0" (standard and initial setting), the Return To Home (Origin) Position is performed starting with the 1st arm (X-axis) and after completion of the 1st arm, the return to Home (Origin) Position of the 2nd arm (Y-axis) is performed.

2) When the parameter setting is "1", the Return To Home (Origin) Position is performed starting with the 2nd arm (Y-axis) and then the 1st arm (X-axis).

NOTE:
The Home positioning, order of the optional joints can not be changed. Refer to Chapter 7 "ROBOT ADJUSTMENT" for detail.

No.17: TIP WEIGHT (in Kilogram)

This parameter sets the arm tip weight (work piece weight + tool weight + optional joints weight etc.) in Kilogram.

- The maximum load (tip weight) must not exceed 10 kg/22 lbs.
- Since the tip weight is the converted value into the tip load of the standard arm (length: 500 mm/19.7 in), calculate the tip weight in consideration to the inertia moment as following example when the arm length is altered.

EX. Arm length : 500 mm/19.7 in → 5 kg/11 lbs
: 550 mm/21.7 in → $5 \text{ kg} \times (550/500)^2 = 6 \text{ kg}/13 \text{ lbs}$

Positioning is performed in an accelaration/deceleration pattern most suited to the tip weight.

CAUTION:

If a suitable value has not been set (if the set value is considerably lower than the actual tip weight), the Manipulator may be adversely affected.

Nos.18 and19: Not used.

No.20: Not used.

No.21: X + SOFT LIMIT ("+" direction first travel limit in pulses)

No.22: X − SOFT LIMIT ("−" direction first travel limit in pulses)

No.23: Y + SOFT LIMIT ("+" direction first travel limit in pulses)

No.24: Y − SOFT LIMIT ("−" direction first travel limit in pulses)

Set parameters (Nos. 21~24) inside of the range of the second travel limits at least 10,000 pulses (Refer to 7-2-4 "RELATION BETWEEN LIMIT SWITH AND DOG").

By setting the first travel limits (soft limits) inside the second limits, it is possible to check input data in the Manual Mode without the Robot reading the second limit any going into the EMERGENCY condition.

When the arm reaches the first travel limit (soft limit), touch the opposite direction key for that arm (i.e. if the 1st arm (X-axis) does not move when touching the "X+" key, then touch the "X−"key vice versa) to return the arm within the first travel limit (soft limit) range.

− MEMO −

No.25: X ORIGIN SHIFT (1st arm Home Position shift)

No.26: Y ORIGIN SHIFT (2nd arm Home Position shift)

If for any reason exceptional force is applied to the arm(s), it causes the arm(s) to be out of the Home (Origin) Position. These parameters (Nos.25 and 26) can be used to shift the Home (Origin) Position to the original position.

NOTE:
These procedures save having to teach all point data again.

The Home (Origin) Position shift amount for the arms is specified as follows:

1) In Semi-Automatic Mode, move the arms to one point (where has been set in the program) by using the "RUN" key. Keep the record of that point data which is displayed on the screen.
2) Move the arms to the actual work point and keep the record of the actual work point data.
3) Calculate the shifting amount of the Home (Origin) Position by using the actual work point data and the point.data set in the program as following example.

EX. Actual working point data: $X' = 75231$ $Y' = 48300$

Point data set in the program: $X = 73651$ $Y = 51621$

$\therefore$ $X' - X = 75231 - 73651 = 1580$
$Y' - Y = 48300 - 51621 = -3321$

The results show the shifting amount of the Home (Origin) Position.

This means that by setting parameter No.25 to "1580" and parameter No.26 to "−3321", all data can be corrected.

Nos.27 and 28: Not used

No.29: X ARM LENGTH (1st arm length in millimeter x 100)

No.30: Y ARM LENGTH (2nd arm length in millimeter x 100)

These parameters set the lengths of the 1st and 2nd arms (X and Y axes).

- Standard and initial values for each model are as follows:

  YK5012 ..... No.29 = 25000
  No.30 = 25000

- Depending on the conditions of use, 2nd arm length can be changed as required. In such case, it becomes necessary to change the standard parameter No.30.

NOTE:
When using the X-Y coordinate system, the values of the standard parameters No.29 and No.30 are very important as basic data. Be sure to perform these parameter settings properly. If not, the Robot will not be able to perform the functions of X-Y coordinate system accurately.

No.1: R JOG SPEED (manual speed in r.p.m.)

This parameter sets the 4th joint (R-axis) motor speed in the Manual Mode.
(Refer to the standard parameter No.1 in 7-4-2-1 for the speed settings.)

No.2: R TPB SPEED (Teaching speed in r.p.m.)

This parameter sets the 4th joint (R-axis) motor speed in teaching in the Program Mode or Point Data Mode.

No.3: R PTP SPEED (point to point speed in r.p.m.)

This parameter sets maximum speed of the 4th joint (R-axis) in the Automatic, Semi-Automatic or Trace Mode.
(Refer to the standard parameter Nos.4 and 5 in 7.4.2.1. for the speed settings.)

Nos.4 and 5: Not used.

No.6: R TOLERANCE (in pulses)

This parameter sets the 4th joint (R-axis) tolerance. When all arms and joints (all axes) have entered the tolerance range, the Robot can perform the next one line of command in the user program.

The standard and initial value is set to "8".

No.7: R OUT POSITION (out effective position in pulses)

When the 4th joint (R-axis) is installed, this parameter sets the out-signal output position.

Outputs are activated when the 1st and 2nd arms (X and Y axes) are within the standard parameter No.13 and the 4th joint (R-axis) enters into the range of this parameter.

Nos.8 and 9: Not used.

No.10: R RETENTION (4th joint direction hold)

This parameter sets the 4th joint (R-axis) direction hold (position control) function to valid or invalid.

0: Invalid

1: Valid

If this parameter is set to "1", the 4th joint (R-axis) maintains its orientation which can be determined by the "R+" or "R−" keys when moving the 1st arm or 2nd arm in the Manual Mode or Program Mode.

No.11: Z JOG SPEED (manual speed in r.p.m.)

This parameter sets the 3rd joint (Z-axis) motor speed in the Manual Mode.
(Refer to the standard parameter No.1 in 7-4-2-1 for the speed settings.)

NO.12: Z TPB SPEED (teaching speed in r.p.m.)

This parameter sets the 3rd joint (Z-axis) motor speed in teaching in the Program Mode or Point Data Mode.

NO.13: Z PTP SPEED (point to point speed in r.p.m.)

This parameter sets maximum speed of the 3rd joint (Z-axis) in the Automatic, Semi-Automatic and Trace Mode.
(Refer to the standard parameter Nos.4 and 5 in 7-4-2-1. for the speed settings.)

Nos.14 and 15: Not used.

No.16: Z TOLERANCE (in pulses)

This parameter sets the 3rd joint (Z-axis) tolerance range. When all arms and joints (all axes) have entered each tolerance range, the Robot can perform the next one line of command in the user program.

The standard and initial value is set to "8".

No.17: Z OUT POSITION (out effective position in pulses)

When the 3rd joint (Z-axis) is installed, this parameter defines the number of pulses from the taught position the axis must attain before the taught outputs are activated.

Outputs are activated when the 1st and 2nd arms (X and Y axes) are within the standard parameter No.13 and the 3rd joint (Z-axis) enters into the range of this parameter.

Nos.18~20: Not used.

No.21: Z+ SOFT LIMIT (first travel limit in pulses)

No.22: Z− SOFT LIMIT (first travel limit in pulses)

No.23: R+ SOFT LIMIT (first travel limit in pulses)

No.24: R− SOFT LIMIT (first travel limit in pulses)

Set these parameters (Nos.21~24) within each operating range.
By setting the first travel limits (soft limits), it is possible to check input data during the manual data input whether the point data is within the working area or not, and also to prevent the arm reaching its operating range end.

When the joint reaches the first travel limit (soft limit), touch the opposite direction key for that joint (i,e, if the 3rd joint (Z-axis) does not move when touching the "Z+" key, then touch the "Z−" key vice versa) to return the joint within the first travel limit (soft limit).

No.25: Z ORIGIN SHIFT (3rd joint Home Position shift)

If for any reason exceptional force is applied to the 3rd joint (Z-axis), it causes the joint to be out of the Home (Origin) Position.

This parameter can be used to shift the Home (Origin) Position to the original position.

If the 3rd joint is installed, refer to the standard parameter No.25 setting procedures in 7-4-2-1. for detail.

No.26: R OFFSET PULSE (4th joint offset angle in pulses)

This parameter sets the angle (in pulses) of the 4th joint (R-axis) from the 2nd arm (Y-axis) after returning to the Home (Origin) Position.

Nos.27~30: Not used.

– MEMO –

7-5 CRT ADJUSTMENT

7-5-1 CRT ADJUSTMENT POINTS

1) H-HOLD
2) CONTR
3) V-HEIGHT
4) V-HOLD
5) BRIGHT

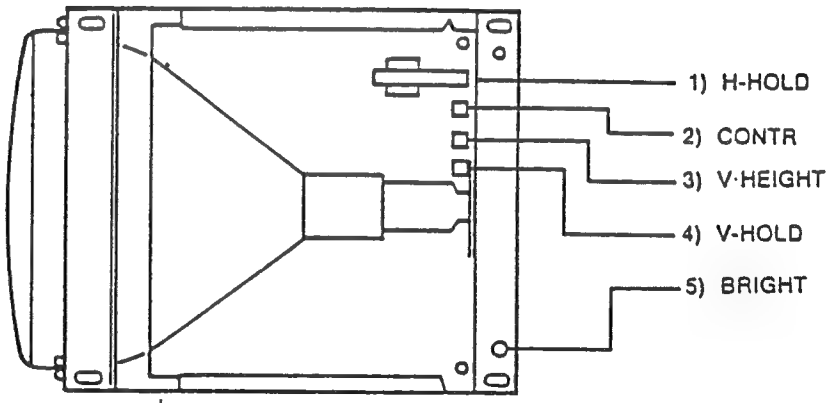


FIG. 7-14 CRT Adjustment Points

7-5-2 CRT AJUSTMENT

The CRT has been adjusted by the factory or distributor at the time of shipping. Only in cases where it is necessary to adapt the CRT to the environmental conditions of the location of use or where there have been changes in temperature or other environmental conditions should the 5 points shown in FIG. 7-14 be adjusted as follows.

WARNING:

Care must be taken because high voltage is used in the CRT.

1) H-HOLD (Horizontal hold)
This trimmer is used for adjustment of horizontal synchronization.

2) CONTR (Contrast)
This trimmer is used for contrast adjustment.

3) V-HEIGHT (Vertical height)
This trimmer is used for adjustment of vertical height.

4) V-HOLD (Vertical hold)
This trimmer is used for adjustment of vertical synchronization.

5) BRIGHT
This trimmer is used to adjust brightness. Do not adjust in too bright as this will shorten the service life of the CRT and may cause it to burn out prematurely.

7-6 DRIFT CHECK

The drift of the motor driver units (amplifiers) has been adjusted by the factory. However, it is necessary to readjust the drift when the environmental conditions (mainly temperature) have changed.

NOTE:
The controller should be installed on the place where is maintained at constant temperature and humidity to prevent characteristics of drivers from changing.

Adjustment procedure:

1) Touch [MANUAL] :

This key selects the Manual Mode.

2) Touch [⊕] with [LOWER] :

The position of each arm is displayed and changes according to the drift condition of the motor driver (non hold condition).

3) When the arm drifting is very large, adjust the "ZR" trimmer on the front panel of the motor driver unit with a screw driver to minimize the drifting (within 50 pulses/minute).

4) After completing the adjustment;

Touch [⊕] with [LOWER] :

The controller returns to the normal (hold) condition.

NOTE:
If the controller is left as the non hold condition with the power switch on, the arms will start drifting and reach the 2nd travel limit. Make sure the controller returns to the hold condition after drift check.

CHAPTER 8
OPTION

CHAPTER 8
OPTIONS

8-1 DESCRIPTION

USR has provided the following optional devices for using the Maker Robot more efficiently (ask your authorized distributor for details).

This chapter explains the applications of the following devices:

- Teach Pendant
- External Memory (Bubble) Cassette Unit
- Printer

NOTE:
The external memory unit and printer are located in one carrying-case.

8-2 TEACH PENDANT

The teach pendant is used when teaching point data to the Robot by following the arm position.

NOTE:
The teach pendant cannot let the Robot run a program.

FIG. 8-1 shows the external view and cable connection of the teach pandant. Refer to 4-3 in Chapter 4 "OPERATION" for the key types and layout.

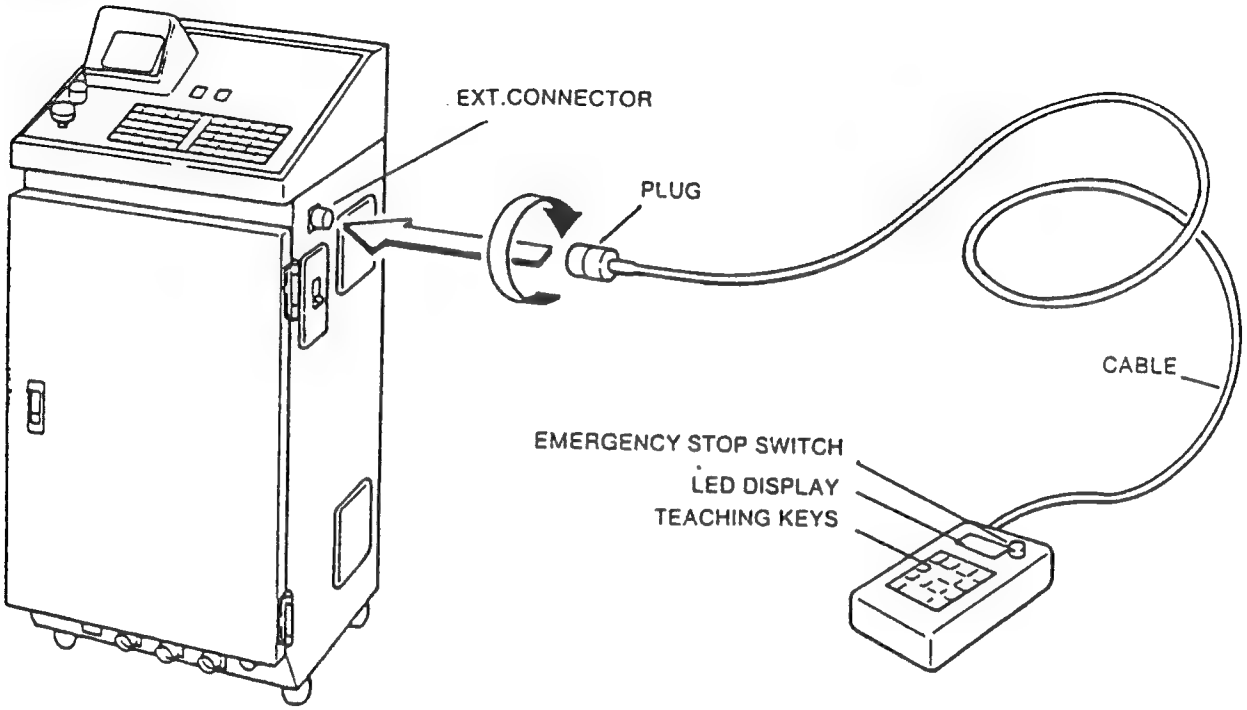


FIG. 8-1 Teach Pendant

8-2-1 OPERATION

The teach pandant can be used for teaching a point data in the Program Mode and Point Data Mode and for setting the standard and shift coordinates.

The general operations of the teach pendant is as follows.

1) Be sure to connect the plug to the EXT connector on the upper right side of the controller. See FIG. 8-1.

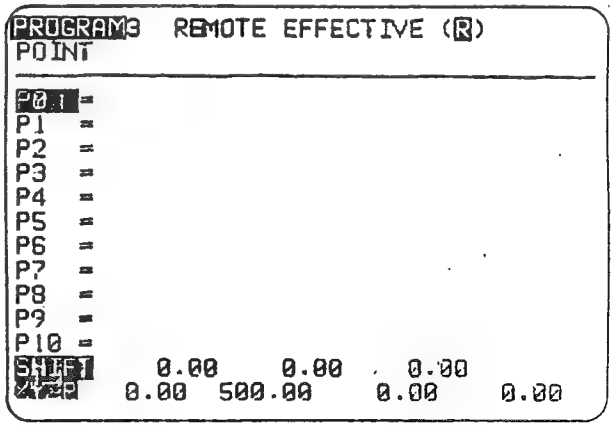
2) **Touch** [PROG] **and/or** [P] **:**

These keys select the Program Mode or Point Data Mode.

3) **Touch** [R] **:**

This key switches the Robot control from the controller to the teach pendant.

The "REMOTE EFFECTIVE (R)" message is displayed on the top of the screen.



4) **Touch** [STEP UP] **or** [STEP DOWN] **:**

These key move the * mark or reversed point number up or down, and you can store the point data in the * mark line or reversed point number line.

LED on the teach pendant also displays the point number in the Point Data Mode.

If the point data had been stored in the designated point number, a red small lamp is lit on the left side of the LED display.

5) **Touch** [←] [→] [↑] [↓] [↥] [↧] [⟳] [⟲] **:**

These keys move the arms/joints to desired position for the point teaching.

6) **Touch** [⇨] **:**

This key teaches the current point data to the Robot.

7) **Touch** [R] **:**

When using the teach pendant, this key returns the Robot control to the controller.

NOTE:
For details of using the teach pendant in each situation, refer to Chapter 5 "PROGRAMMING".

8-3 EXTERNAL MEMORY (BUBBLE) STORAGE AND PRINTER UNIT

This unit consists of the external memory (bubble cassette) unit, thermal printer unit, and connection cable as shown.

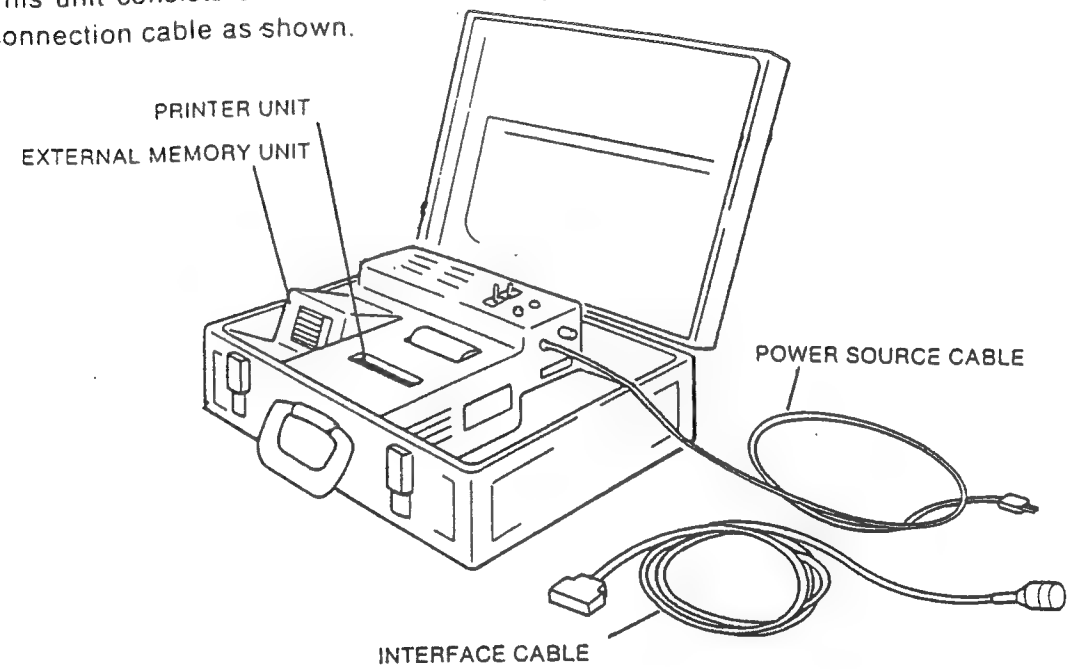


FIG. 8-2 External Memory Storage and Printer Unit

8-3-1 CONNECTION AND SWITCHES

8-3-1-1 CONNECTION

Connect the external memory storage and printer unit cables as shown.

Required power supply: AC 90~120V, 50 or 60 Hz

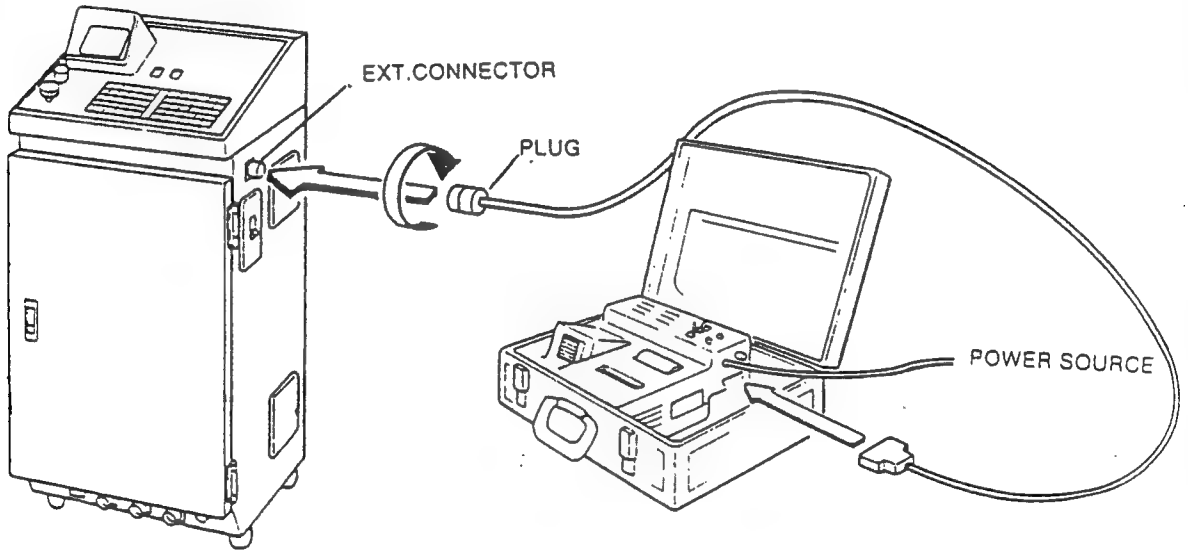


FIG. 8-3 Cable Connections

8-3-1-2 SWITCHES

a. Power switch: Unit ON/OFF switch. When turning ON, the LED on the panel is lit.

b. Select switch: This switch selects the unit function for the external memory or printer.

c. Paper feed switch: This switch is used for feeding the paper. Paper is fed as long as the switch is pressed.

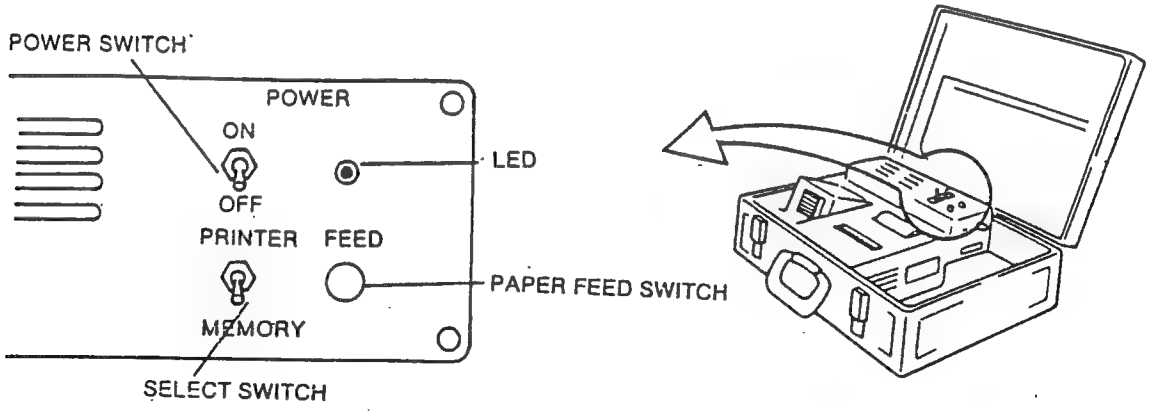


FIG. 8-4 Switches

8-3-2 MEMORY (BUBBLE) CASSETTE

8-3-2-1 LOADING/UNLOADING CASSETTE

1) Open the cover of the memory unit.

2) Insert the cassette into the memory unit and push it until the connector pins are engaged securely with the connector sockets. When the cassette is placed properly, the cassette eject lever on the right side of the socket pops out.

   NOTE:
   Make sure the cassette is installed right side up.

3) While the cassette is in the operation, the red LED goes on and off.

4) To remove the cassette, push the cassette eject button and pull out the cassette.

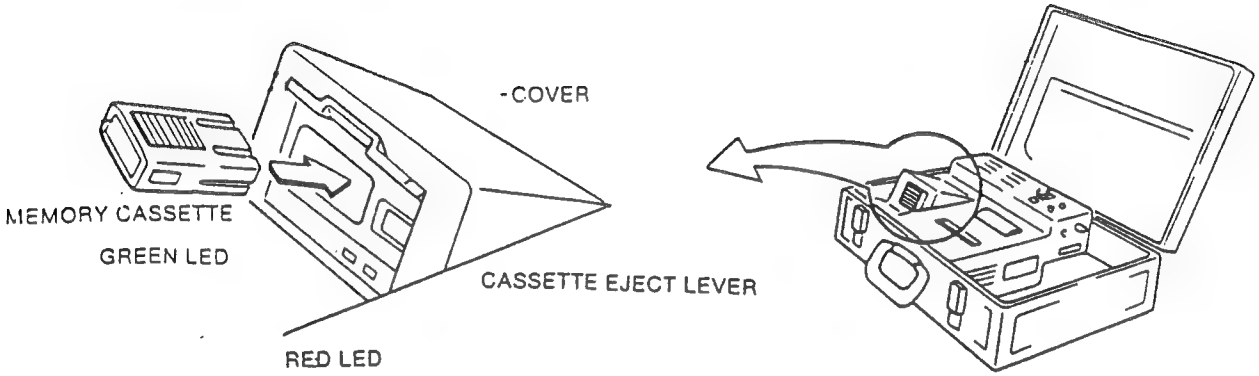


FIG. 8-5 Loading and Unloading Cassette

8-3-2-2 WRITE-PROTECTION SWITCH

1) For writing data in the cassette, slide this switch toward the arrow mark.

2) For protecting written data in the cassette, slide this switch in the opposite direction. When loading the write-protected cassette into the unit, the green LED is lit.

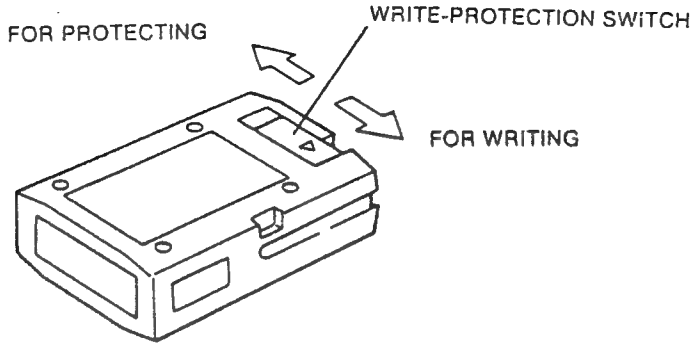


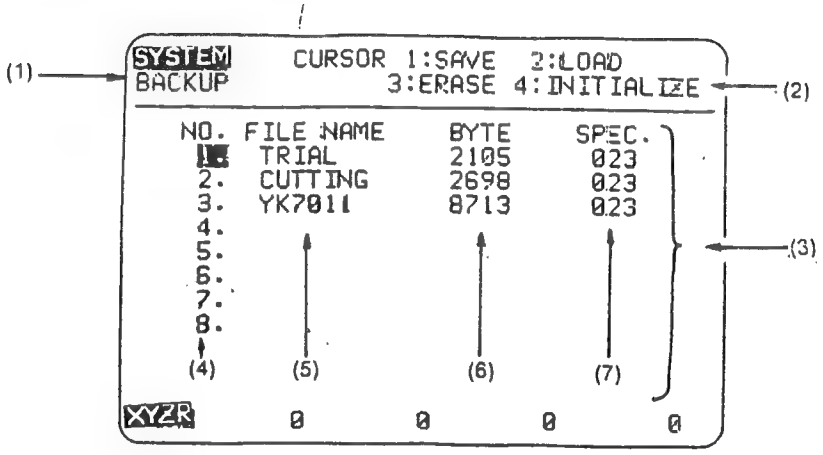
FIG. 8-6 Write-Protection Switch on the Cassette

3) Memory capacity of cassette :

One cassette is able to save eight controller's data.

MAXIMUM MEMORY CAPACITY: 16 Kbytes x 8 controllers = 128 Kbytes

8-3-2-3 SCREEN FORMATS



(1) The area of the title display.

(2) The area of the operation menu display:
The presently effective key and its function are displayed.

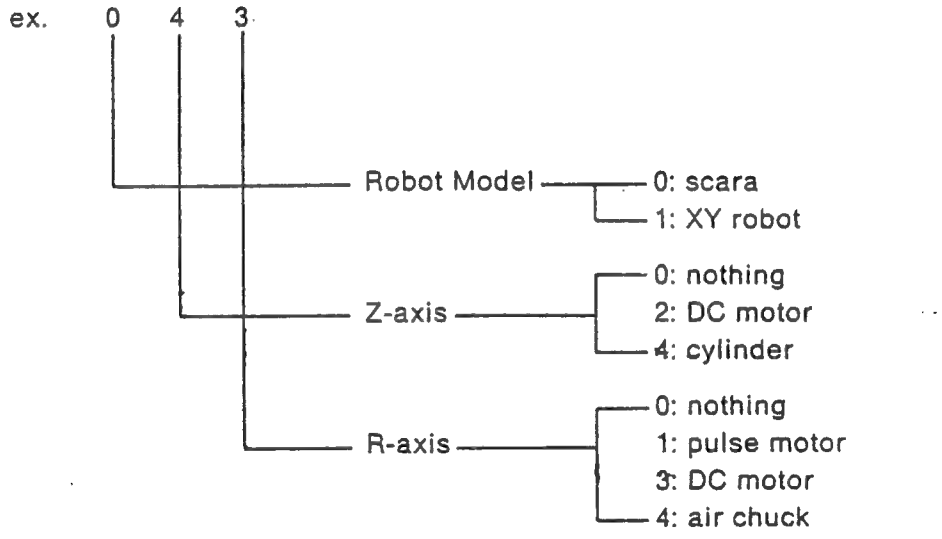
(3) The area of a list of files.

(4) File No.: SAVE, LOAD and ERASE commands are effective for the file corresponding to the reverse video number on the display. Use the up-down cursor keys to select different files.

(5) File name:
A maximum length of filename is eight characters. Alphabet and numerics can be used for the filename. When changing the filename, touch the "→" key.

(6) Number of used bytes: The total of the used bytes of the file.

(7) Robot specifications:

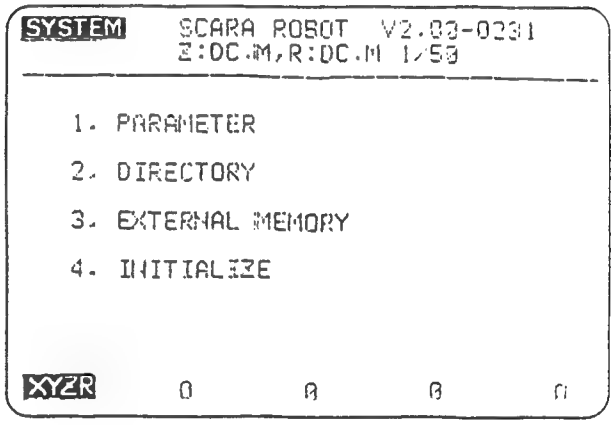


8-3-2-4 OPERATION

To start operating the external memory (bubble) storage unit, proceed the following steps after making sure the proper connection, proper cassette insertion, power switch is ON, and selector switch is "MEMORY".

1) Touch [SYSTEM] :

The system menu is displayed on the screen.

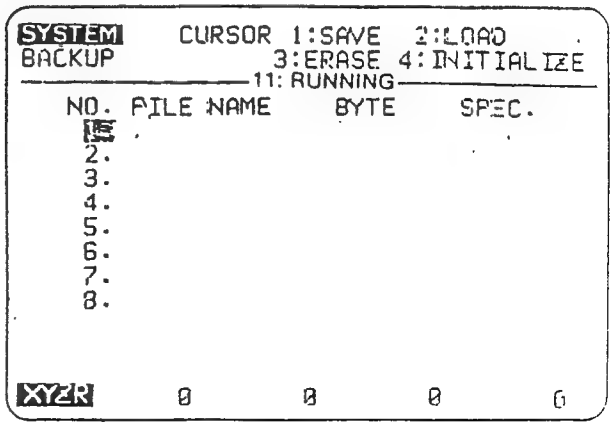


2) Touch [3] :

This key selects the operation of the external memory storage unit.

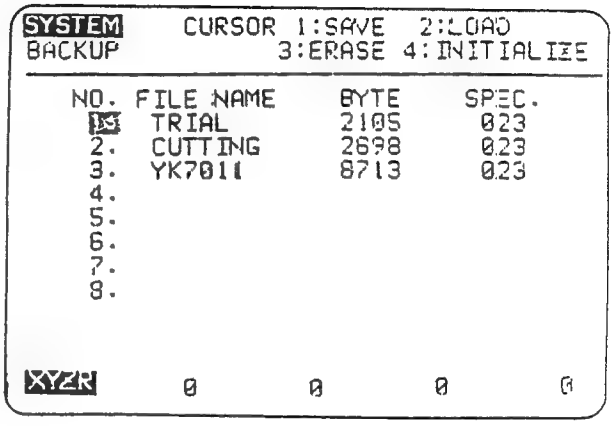
The file directory is loaded from the external memory.

NOTE:
The "RUNNING" message is displayed whenever bubble cassette is accessed.



After loading the file directory, the data (file name, used bytes and Robot specification) are displayed.

The operation menu is displayed on the upper of the screen.



8-3-2-5 INITIALIZE

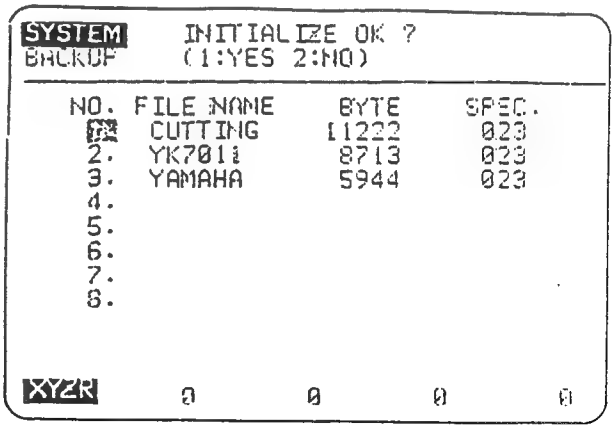
When using a new memory (bubble) cassette or erasing all data in used cassette, initialize it by proceeding the following the steps after having performed 8-3-2-4 "OPERATION".

CAUTION:

Be careful since initializing erases all data in the memory cassette.

1). Touch [4] :

The key selects the initializing procedure.

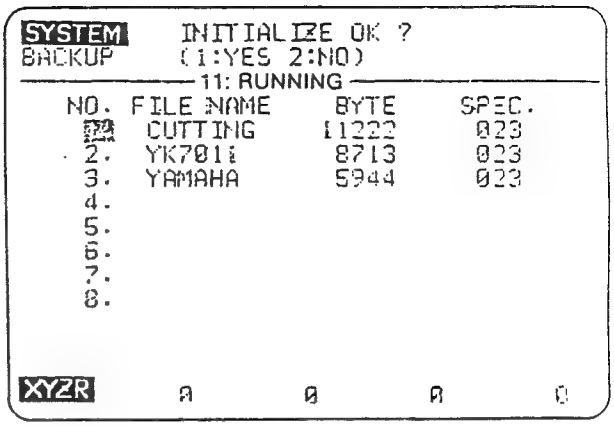


2) Touch [1] :

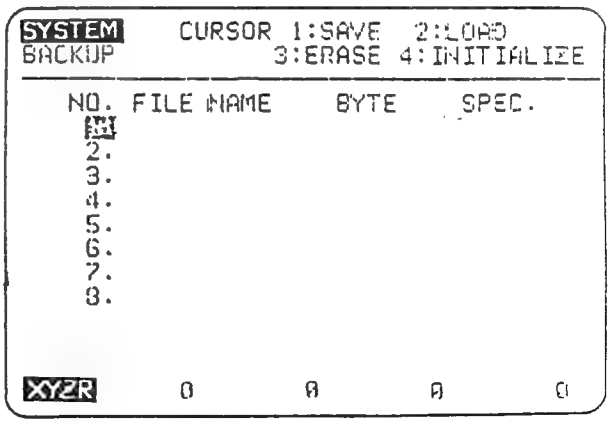
Initialize is performed.

The "RUNNING" message is displayed on the screen while initializing.

NOTE:
When the "2" key is touched, the cassette is not initialized.



After initializing, the data of the file name, used bytes and Robot specification in the cassette is erased and the operation menu is displayed again.



NOTE:
Once the initializing procedure is performed, it is not necessary to perform it again unless all data is to be erased.

When the memory volume of the controller reaches 13Kbytes, the "MEMORY FULL" message is displayed on the screen.

In such a case, store the data of the controller to the memory cassette. We also recommend storing controller data to the memory cassette for backup purposes.

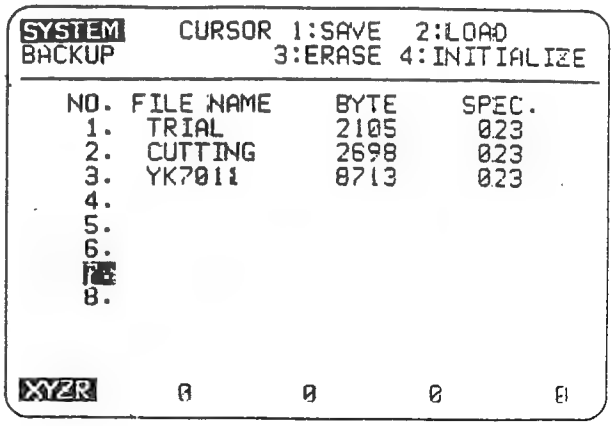
Proceed to the following procedures after having performed 8-3-2-4 "OPERATION".

a. Storing the NEW file

1) Touch [↑] or [↓]:

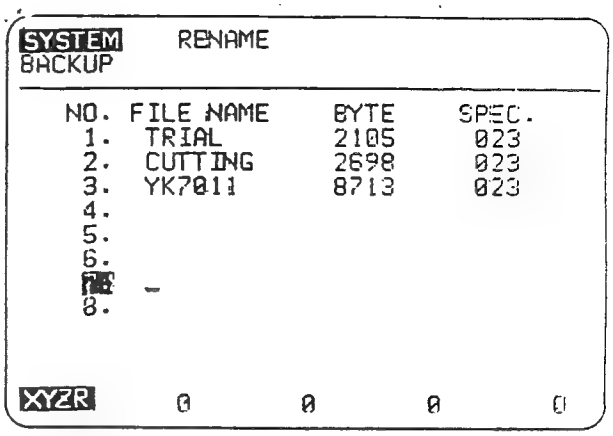
This key moves the reverse video display of the file number up or down and you can store the data in the reverse video displayed number file.

NOTE:
It is possible to use any file number which is not in use.



2) Touch [→]:

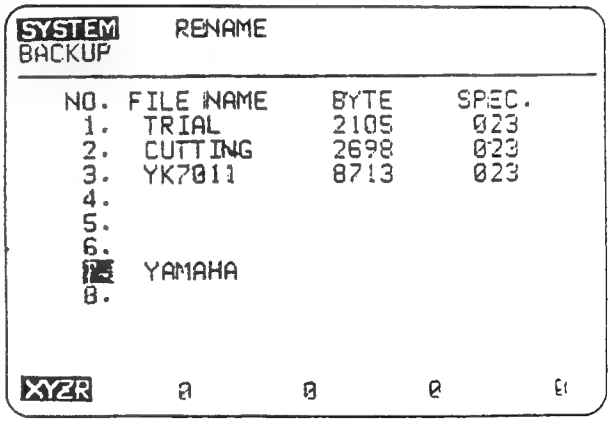
The "RENAME" message and cursor are displayed on the screen, prompting the input of the file name. This screen shows that the file No. 7 is selected.



3) Touch [A]~[Z] and/or [0]~[9]:

Input the file name by these keys. For the file name, you can use any digits of 0 through 9 and any letters of A through Z within eight (8) digits and/or letters in total.

This screen shows that the "YAMAHA" is inputted as a file name.

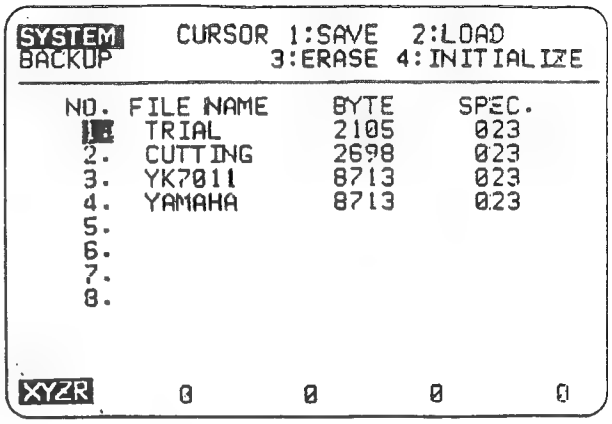


b. File renaming

When the file renaming is necessary, proceed as follows.

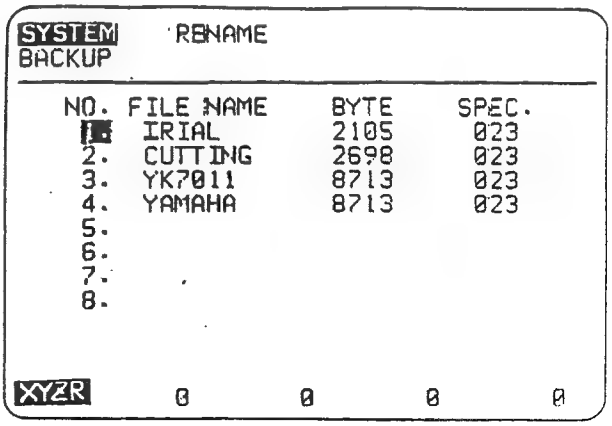
1) Touch [↑] or [↓]:

Select file No. by using these keys. This screen shows the file No.1 is selected.



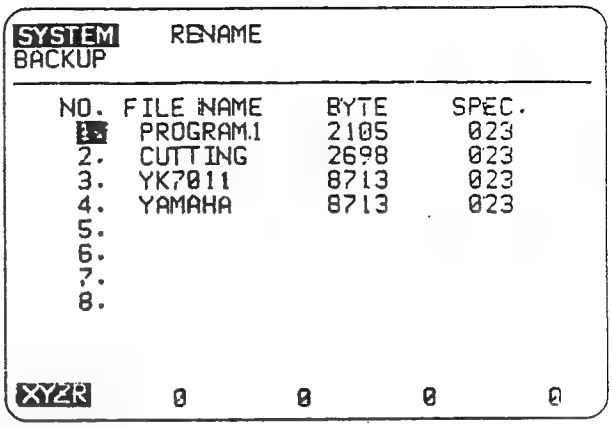
2) Touch [→]:

The "RENAME" message and cursor are displayed on the screen, prompting the input of the file name.



3) Touch [A]~[Z] and/or [0]~[9]:

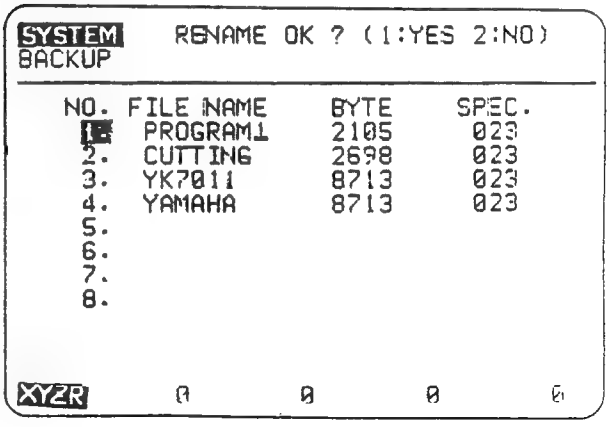
Input the new file name by these keys.



4) Touch [↵]:

This key completes input of the new file name.

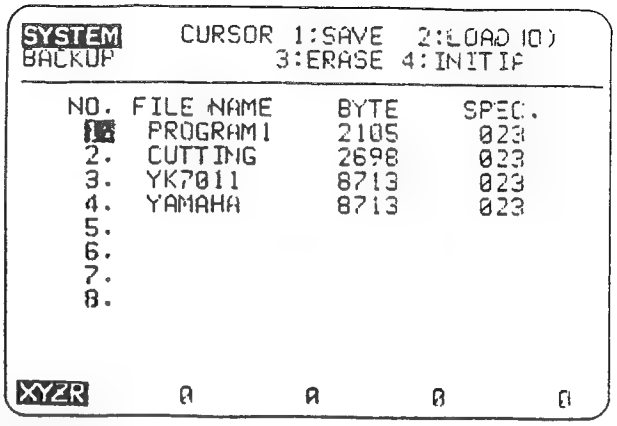
The confirmation message is displayed on the top of the screen.



5) Touch [1] :

After touching the "1" key, renaming is complete.

If you want to cancel the renaming, then touch the "2" key.
The screen is canceled and changed into the operation menu screen.

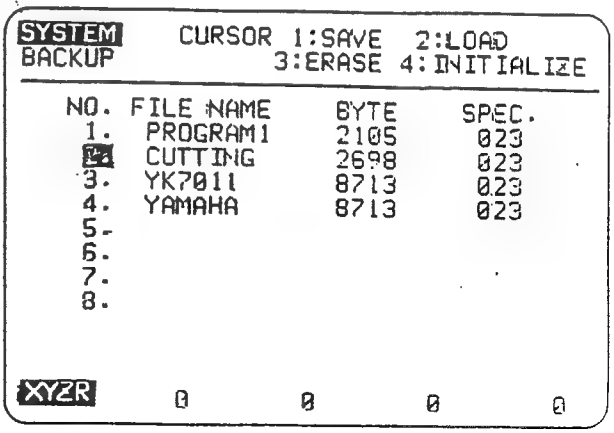


c. File rewriting

1) Touch [↑] or [↓] :

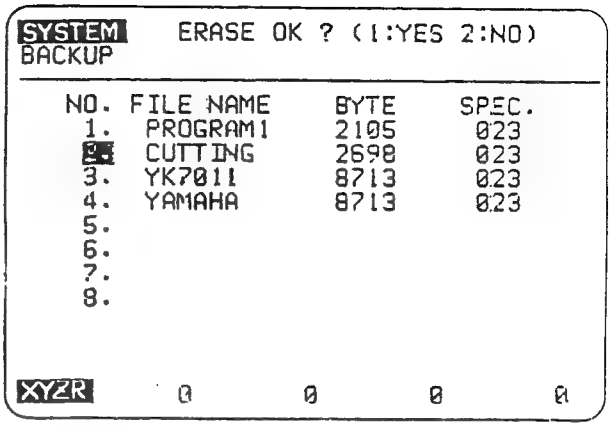
Select the file No. by using these keys.

This screen shows the file No.2 is selected.



2) Touch [1] :

The confirmation message "ERASE OK?" is displayed on the screen before the file rewriting is performed.

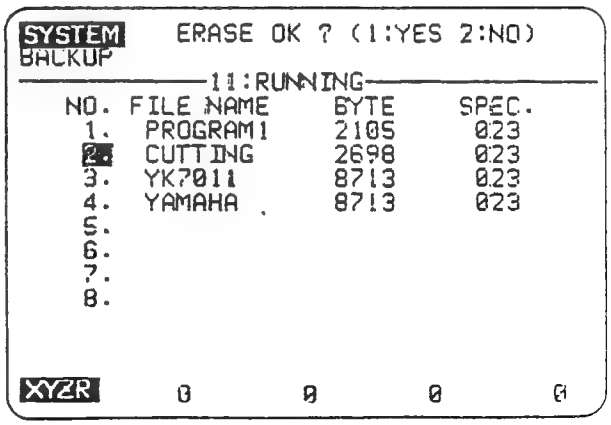


3) Touch [1] :

When touching the "1" key, the file re-writing can be performed and the "RUNNING" message is displayed.

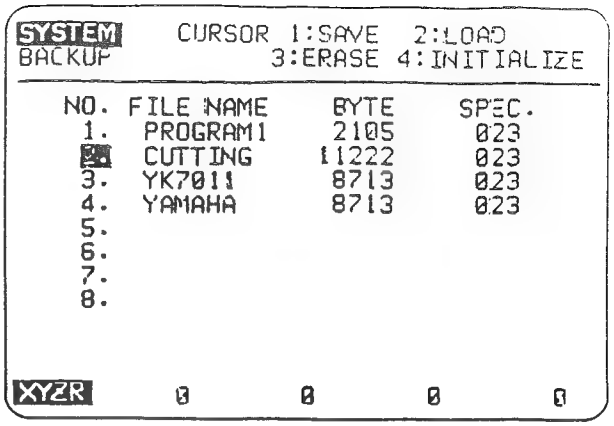
The current controller's data is stored into the selected file No.

If you want to cancel the file rewriting, then touch the "2" key. The screen is canceled and changed into the operation menu screen.



When the file rewriting is completed, the used bytes and specification is displayed on the screen.

This screen shows the file No.2 rewriting.



8-3-2-7 DATA LOAD

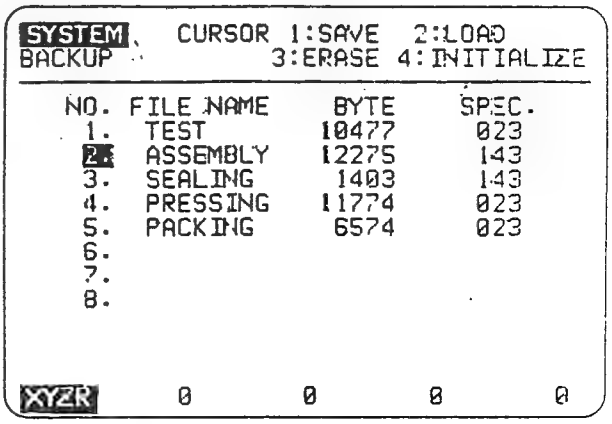
When loading the data of the memory cassette into the controller, proceed as follows after having performed 8-3-2-4 "OPERATION".

NOTE:
The external memory data replaces the all current data in the controller.

1) Touch [↑] or [↓]:

This key moves the reverse display of the file number up or down and you can load the data in the reverse displayed number file.

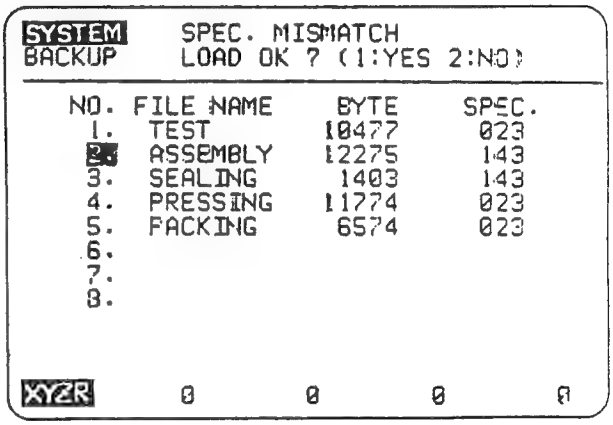
This screen shows that the file No.2 is selected.



2) Touch [2]:

The confirmation message "SPEC. MISMATCH LOAD OK?" is displayed on the screen when the specification of the loading data differs from the Robot specification. That is, if the data on the cassette was stored from a controller with a different axis configuration.

NOTE:
If they have the same specifications, the message is not displayed.

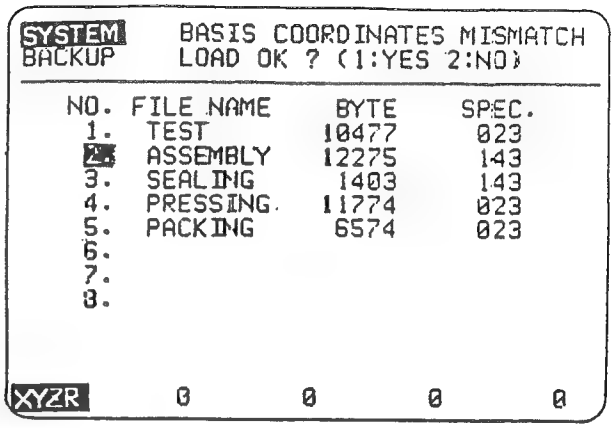


3) Touch [1] :

The confirmation message "BASIS COORDINATES MISMATCH LOAD OK?" is displayed on the screen when the coordinates information of the loading data differs from the Robot information.

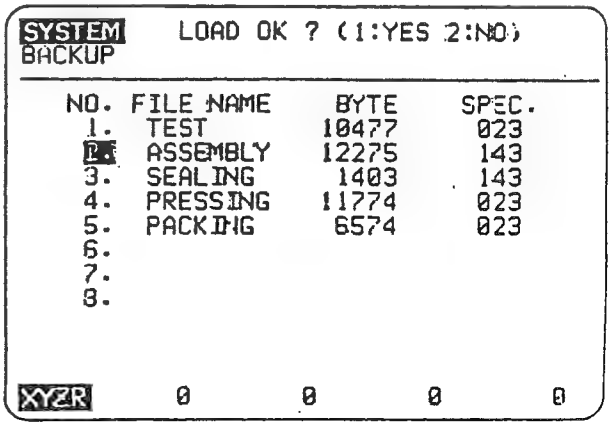
NOTE:
If they have same information, the message is not displayed.

If you want to cancel the process, then touch the "2" key. The screen is cancelled and changed into the operation menu screen.



4) Touch [1] :

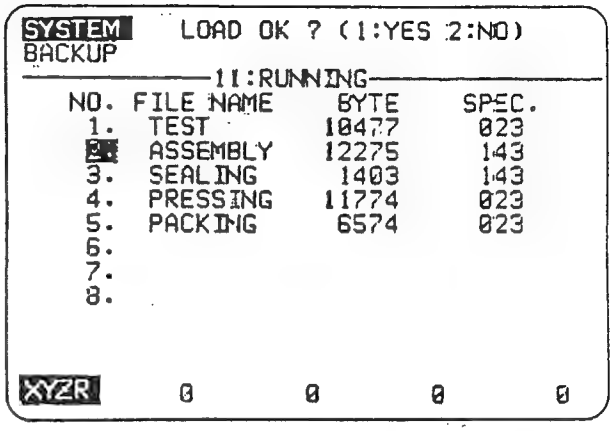
The confirmation message "LOAD OK?" is displayed on the screen.



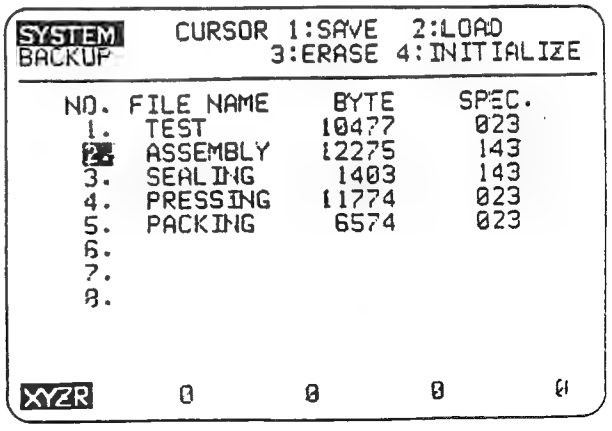
5) Touch [1] :

When touch the "1" key, the loading is performed. While loading, the "11: RUNNING" is displayed on the screen.

If you want to cancel the loading, then touch the "2" key. The screen is cancelled and changed into the operation menu screen.



When the loading is completed, the screen is returned to the operation menu screen.



8-3-3 PRINTER

8-3-3-1 PAPER LOADING

1) Remove the panel cover from the printer unit. See FIG. 8-7.

2) Pull the paper release lever all the way forward and insert the paper into the printer unit as shown. See FIG. 8-8.

NOTE:
- **Cut the paper and as shown before setting the paper for easy paper setting.**
- **The printing paper for this printer can be printed on the face side only. Make sure the paper face is correct.**

3) After setting the paper properly, return the paper release lever all the way back.

The paper is held firmly in place.

4) Reinstall the panel cover onto the printer unit and secure it by holding screws.

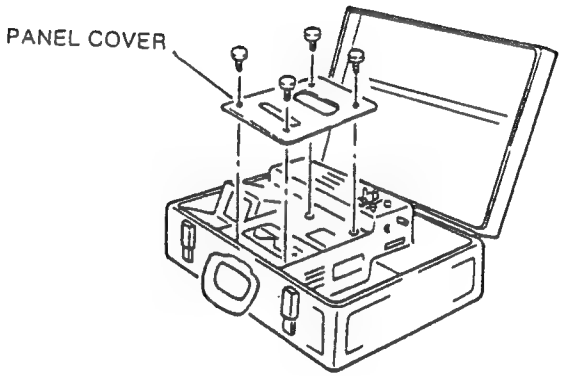


FIG. 8-7 Cover Removal

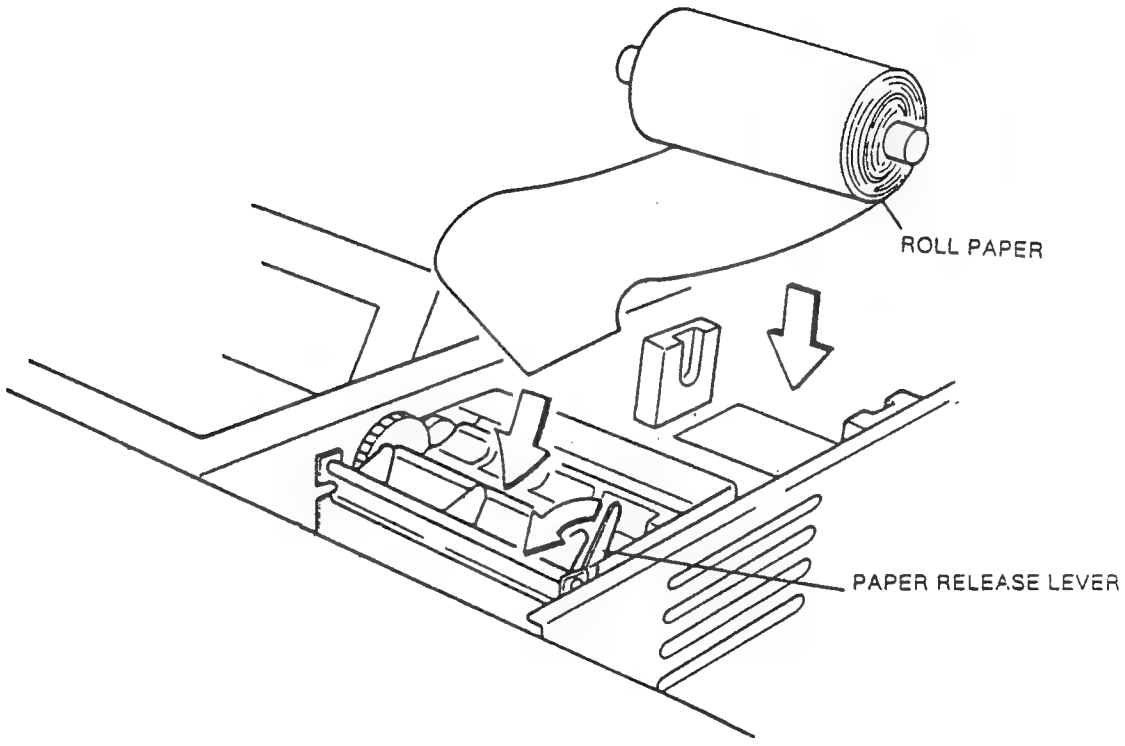


FIG. 8-8 Paper Loading

8-3-3-2 OPERATION

The printer can be operated by running a program when the printing command is added into the program as follows.

1) Put the PRINTER/MEMORY switch on the bubble memory/printer unit into the PRINTER position.

2) Add the printing command into the program as examples in the program mode. (Refer to Chapter 5 "PROGRAMMING".)

CODING EXAMPLES:

a. prints all programs ..... SEND PGM TO PRN

b. prints one program named <ABC> ..... SEND <ABC> TO PRN

c. prints all point data ..... SEND PNT TO PRN

d. prints the part of point data .....
- SEND P10 TO PRN
- FOR A=1 TO 10
  SEND PA TO PRN
  NEXT A
- SEND P1 −− TO PRN

e. prints all parameters ..... SEND PRM TO PRN

3) Perform the program in the Automatic, Semi-Automatic, or Trace Mode.

NOTE:
- It is possible to stop the printing by using the "STOP" key. To restart the printing, use the "RUN" or "S.UP" keys in the Automatic, semi-Automatic, or Trace Mode.
- When run out of the printing paper, the printer stops printing automatically. However the "RUNNING" message is kept displaying on the screen. In this case, replace the printer paper after turning OFF the power switch of the printer/memory unit and then turn ON. The printer starts the printing again from the following line.

8-3-3-3 PRINT OUT EXAMPLES

a. PROGRAM

```
NAME=PROG10
   "------------ MAIN ------------
   OUT#1 0
10:IF I#2 BIT0=0B THEN 99
   OUT#1 0
   CALL 11
20:IF I#2 BIT3,1=01B THEN 50
   CALL 11
30:IF I#2 BIT4,2=01B THEN 60
   CALL 11
   GOTO 20
50:X=1
52:TIMER 1
   IF I#2 BIT3,1<>01B THEN 30
   X=X+1
   IF X<10 THEN 52
   CALL 11
   IF V=1 THEN 51
   SHIFT S0
   OUT#1 BIT7,4=01B
   CALL S0
   MOV P0 TO P5
```

b. POINT DATA

```
P0  = -79125   92708        0   -4915
P1  =-130796  177561        0   -9149
P2  =-185323  222805        1   -9976
P3  =-185267  222109        1   -9884
P4  =-184424  220886        1   -9855
P5  =-184553  220039        1   -9725
P6  =-181813  219058        1   -9956
P7  =-181946  218370        1   -9854
P8  =-180970  216984        1   -9809
P9  =-181050  216095        1   -9685
P10 =-188412  222999        1   -9601
P11 =-188863  221752        1   -9401
P12 =-189795  221311        1   -9218
P13 =-189862  221271        1   -9125
P14 =-194346  223732        1    5371
P15 =-193260  222897        1    5337
P16 =-192539  221976        1    5365
P17 =-191604  221051        1    5358
P18 =-191693  218845        1    5645
P19 -         [illegible]   1    5652
                            1    5578
```

c. PARAMETERS

```
STANDARD PARAMETER
 1.      300 :X,Y JOG SPEED
 2.      200 :X,Y TPB INCHING
 3.       40 :X,Y TPB HIG SPEED
 4.     2000 :X PTP SPEED
 5.     2000 :Y PTP SPEED
 6.      240 :X,Y CP SPEED
 7.        8 :DATA BIT(5,6,7,8)
 8.        2 :PARITY(0:N,1:O,2:E)
 9.        2 :STOP(1,2,3<=1.5>)
10.        4 :BAUD RATE(*2400BPS)
11.        8 :X TOLERANCE
12.        8 :Y TOLERANCE
13.      500 :XY OUT POSITION
14.        0 :
15.        0 :
16.        0 :TO ORIGIN SEQ.
17.       10 :TIP WEIGHT
18.        0 :
19.        0 :
20.        0 :
21.   400000 :X + SOFT LIMIT
22                SOFT LIMIT
                      LIMIT
```

CHAPTER 9
PERIODIC MAINTENANCE

CHAPTER 9
PERIODIC MAINTENANCE

9-1 INTRODUCTION

Periodic maintenance of the Maker Robot is highly important in order to ensure the safety and efficient operation of the robot. This section describes the procedures for periodic maintenance and requirements for maintenance of the Maker Robot System.

Periodic maintenance consists of:

Daily check:
Six-month inspection: and
Three-year inspection

9-2 PRECAUTIONS

Periodic maintenance shall be carried out in accordance with the following provisions:

- Periodic maintenance shall be carried out by or in the presence of persons who have received the Robot Training Seminar given by USR or its distributors.
- Prior to executing maintenance, turn OFF the overload breaker of the controller.
- Do not touch the internal part of the controller for 30 seconds after the power source of the controller has been turned OFF.
- The lubricating grease to be used shall be only that specified by U S Robots
- When parts are replaced, only those brands specified byU S Robots its distributors shall be used.
- When maintenance is carried out while operating the robot, never enter the area within the working range of the robot.

9-3 DAILY CHECK

Perform this check with respect to the following items before and after operation of the robot each day:

Checking positions	Contents of check
Safeguards	Check whether the safeguards are at the specified position.
Cables	Check cables for blisters, cracks, forced bends and damage.
Motor, encoder and Harmonic Drive	Check for any abnormal vibration, noise, or excessive temperature rise.
Air pressure equipment	• Check the air pressure. • Check for air leaks • Check to see whether the water has drained or not. • Check the air filter.

9-4 SIX MONTH INSPECTION

Perform inspection with respect to the following items every six months:

Checking positions	Contents of check
Main bolts and screws for manipulator	Check for loose bolts and screws and re-tighten loose ones as necessary.
Robot cable (See Chapter 2)	Check for loose connectors and retighten if neccessary.
Arms	• Check for backlash in the bearing section, and if any has occurred, retighten the bearing section. • Check for vibrations during operation, and if necessary, retighten the arm setting bolt.
Ball screw	Coat with grease. The specified grease is Molab Alloy Universal Grease #2 (Dai-Asia Molab Co.).
Secondary limit proximity switch	Move the arm to the second travel limit position in the Manual Mode, and check whether the movement of the arm stops or not "SECOND LIMIT OVER" is displayed on the screen.
Amount of Grid Position when returning to the Home Position (Origin)	Perform the Return to Home (Origin) Position, and check whether the amount of Grid Position is appropriate or not. (Refer to Chapter 7 "ADJUSTMENT")
DC servo motor	Check for worn brushes (Refer to 9-6-1 "MAINTENANCE OF BRUSHES").
Wiring in manipulator	• Check for kinked cable protecting springs. • Check for a loose connector, etc.
Internals of controller	• Check relay contact to see if it functions properly or not. • Check for a loose terminal. • Check for a loose connector.
Air cooling fan on the side of the controller	• Check the fan to insure that it turns properly. • Check for any abnormal noise during rotation. • Check the fan cover and if it is dirty, remove the cover and clean it.

9-5 THREE-YEAR INSPECTION

Perform a three-year inspection every three years in addition to regular six-month inspections with respect to the following contents:

Checking positions	Contents of check
Harmonic drives of joint sections	Perform an overhaul and check the harmonic drives.

9-6 PERIODIC MAINTENANCE

9-6-1 MAINTENANCE OF BRUSHES

Check the wearing conditions of brushes once every six months as part of the periodic maintenance, and when the length of the brushes are near the serviceable limit, replace them as a set.

The serviceable limit length of brush is about half its initial length. Although its life may vary depending upon the load conditions, ambient temperatures, etc., the serviceable limit life of brushes is normally about 2,000 to 3,000 hours. Moreover, whenever the motor brush has been broken, replace it regardless of its length.

CAUTION:

Prior to replacing with a new brush, check to avoid deposition of oil and water.
By no means should the brush be handled with oily hands or stored in a place where oil is likely to deposit.

a. Replacement of motor brushes

1) Dismount the brush holder caps (FIG. 9-1).

2) Remove all brushes (FIG. 9-2).

3) Prepare dried compressed air (pressure: 1 kg/cm² or lower) and blow off carbon deposit produced due to wear. Any carbon deposit, which remains, will cause deterioration of insulation between grounding and result in motor failure. Therefore, thoroughly remove any such deposit (FIG. 9-3).

WARNING:

Wear an eye protector to prevent dust from going into the eyes when blowing off carbon deposits using compressed air.

4) Install the brushes and holder caps.

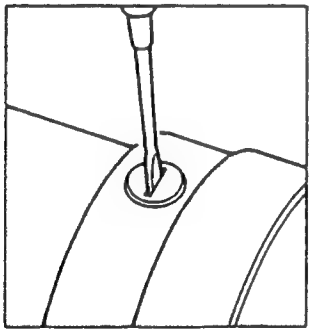


FIG. 9-1

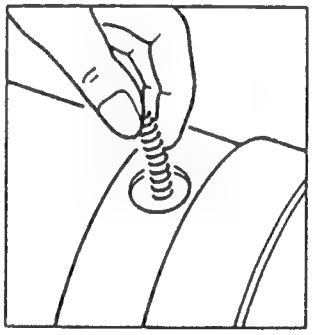


FIG. 9-2

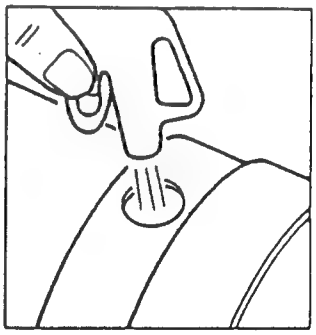


FIG. 9-3

b. Sepcification of brush

	Servo motor	Brush	Type	Q'ty	Initial length L (mm)	Serviceable limit length L' (mm)
X-axis Y-axis Z-axis	U718-012E18	Motor	476978 x 1G16	4	16	8
		Tacho generator	--	—	—	—
R-axis	U508-022E17	Motor	T-A01197	2	6.5	3
		Tacho generator	—	—	—	—

CHAPTER 10
SPECIFICATION

CHAPTER 10
SPECIFICATION

10-1 MANIPULATOR

10-1-1 BASIC SPECIFICATION

Item		Specification	
Model		YK5012	
Structure		Articulated type	
Degrees of freedom		Standard: 2 degrees (1st and 2nd arms) Option: 2 degrees (3rd and 4th joints)	
Drive system		DC servo motor	
Weight		32 kg/70 lbs	
Arm length	1st arm (X-axis)	250 mm/9.85 in	
	2nd arm (Y-axis)	250 mm/9.85 in	
Operating angle	1st arm (X-axis)	300°	
	2nd arm (Y-axis)	290°	
Transmission	1st arm (X-axis)	Harmonic Drive (reduction ratio: 1/80)	
	2nd arm (Y-axis)	Harmonic Drive (reduction ratio: 1/80)	
Maximum speed	1st arm (X-axis)	225°/sec	Resultant speed: 2.9 m/sec/114 in/sec
	2nd arm (Y-axis)	225°/sec	
Motor (1st/2nd arms)		Rating: 75 V, 3.4 A, 3000 rpm	
Encoder		Rotary: 1000 pulses/rev.	
Repeatability		±0.05 mm or less/±0.002 in	
Home (Origin) Position detection		Proximity switch and encoder	
Home (Origin) Position		Adjustable	
Operating limit protection		1. Soft limit (programmable) 2. Hard limit (proximity switch)	
Rated load capacity		10 kg/22 lbs (including the optional joints, toolplate, etc.)	
Body color		Two tone colors of silver and black	

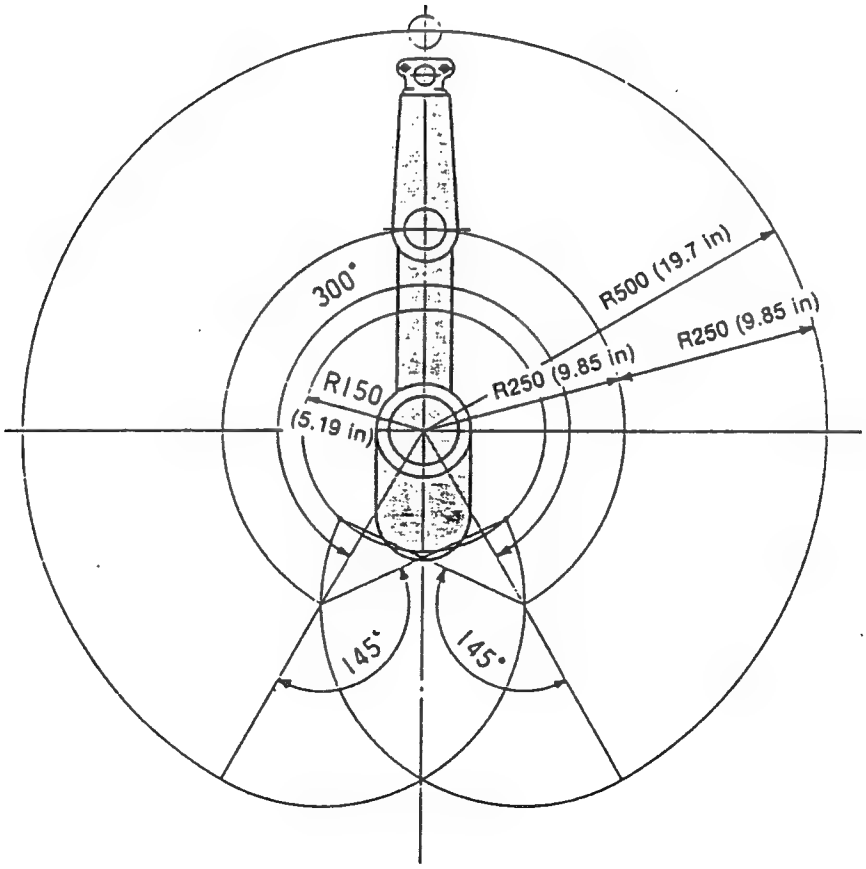


FIG. 10-2 Operating Range

10-1-2 EXTERNAL VIEW AND DIMENSIONS

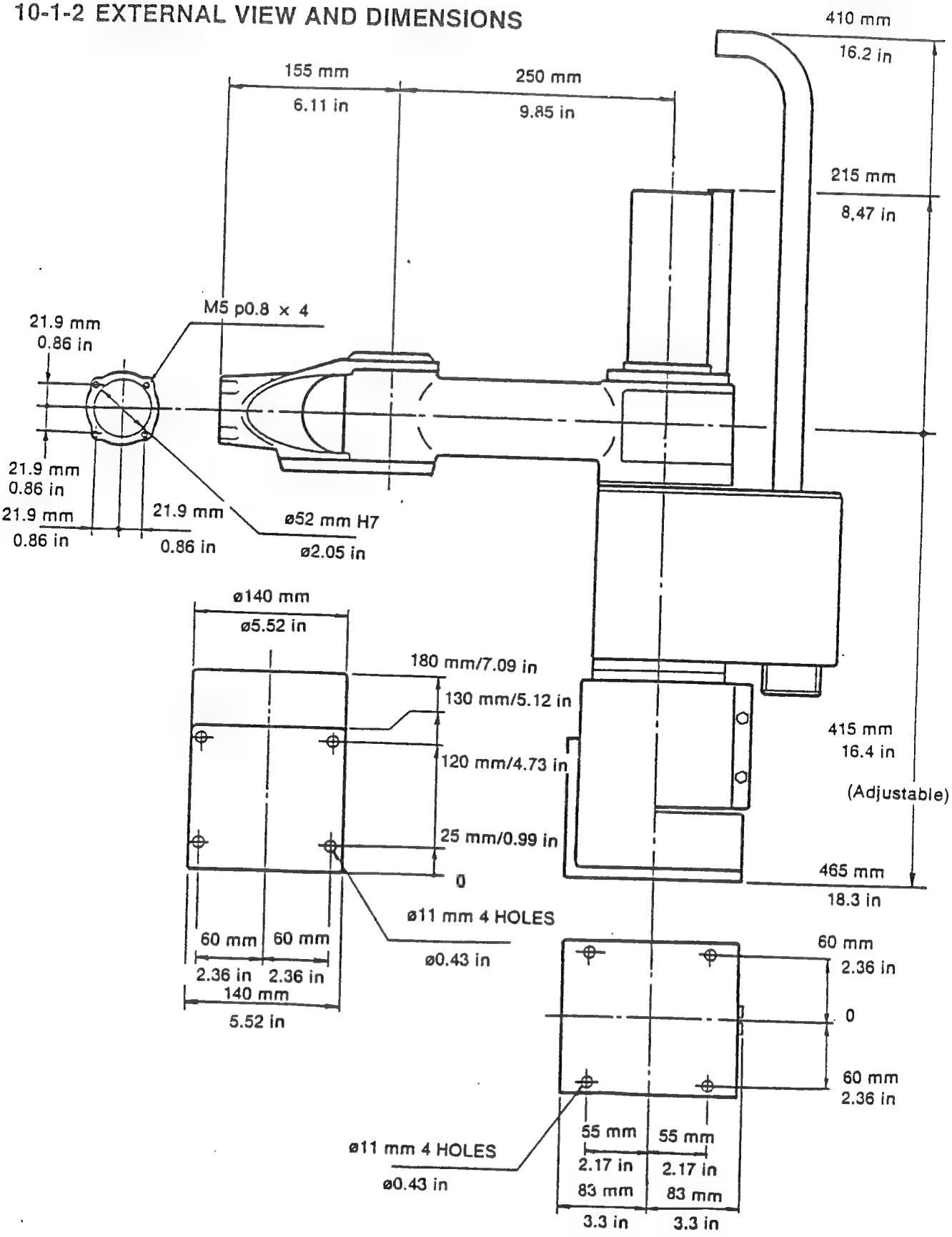


FIG. 10-1 Dimensions of YK5012

10-2 CONTROLLER

10-2-1 BASIC SPECIFICATION

<table>
<tr><th colspan="3">Item</th><th colspan="2">Specification</th></tr>
<tr><td colspan="3">Applicable models</td><td colspan="2">YK5012</td></tr>
<tr><td rowspan="2">Number of controlled axes</td><td>RCS40</td><td rowspan="2">Standard:
2 axes simultaneous</td><td>Option:
3 axes simultaneous</td></tr>
<tr><td>RCS41</td><td>Option:
3 axes simultaneous
4 axes simultaneous</td></tr>
<tr><td colspan="3">Control methods</td><td colspan="2">Semi-closed servo loop control</td></tr>
<tr><td colspan="3">Position control</td><td colspan="2">PTP control, CP control</td></tr>
<tr><td rowspan="3">Position resolution</td><td colspan="2">1st and 2nd joints</td><td colspan="2">0.0011°/pulse</td></tr>
<tr><td colspan="2">Optional 3rd joint</td><td colspan="2">0.002 mm/pulse/0.00008 in/pulse</td></tr>
<tr><td colspan="2">Optional 4th joint</td><td colspan="2">0.0036°/pulse</td></tr>
<tr><td colspan="3">Minimum setting increment</td><td colspan="2">In the joint coordinate system: 1 pulse
In the X-Y coordinate system: 0.01 mm/0.0004 in</td></tr>
<tr><td colspan="3">Point data system</td><td colspan="2">Absolute</td></tr>
<tr><td colspan="3">Teaching methods</td><td colspan="2">M.D.I. (manual data input) and Teaching playback</td></tr>
<tr><td colspan="3">Memory capacity</td><td colspan="2">Approx. 13 K bytes (amounts of program and point data memory)</td></tr>
<tr><td colspan="3">Memory storage</td><td colspan="2">C-MOS RAM with battery backup (Ni-cd battery)</td></tr>
<tr><td colspan="3">External input signals</td><td colspan="2">Exclusive: 6 inputs
General purpose: 8 inputs (expandable to 32 inputs option)</td></tr>
<tr><td colspan="3">External output signals</td><td colspan="2">Exclusive: 6 outputs
General purpose: 8 outputs (expandable to 24 outputs option)</td></tr>
<tr><td colspan="3">External interface</td><td colspan="2">RS-232C interface (option)</td></tr>
<tr><td colspan="3">programming</td><td colspan="2">Robot language (Specially arranged by Yamaha)</td></tr>
<tr><td colspan="3">Shifting function</td><td colspan="2">Home (Origin) position and coordinates shift function</td></tr>
<tr><td colspan="3">Coordinate systems</td><td colspan="2">Joint coordinates (rotational angle of the arms)
X-Y coordinates (rectangular coordinates)</td></tr>
<tr><td colspan="3">Safety function</td><td colspan="2">Watchdog timer</td></tr>
<tr><td colspan="3">Power source</td><td colspan="2">AC 100～120V or AC 200～240V, 50/60 Hz</td></tr>
<tr><td colspan="3">Insulation resistance Max. voltage</td><td colspan="2">100MΩ 500V DC</td></tr>
<tr><td colspan="3">Dimensions</td><td colspan="2">530W × 1100H × 480D (mm)/20.9W × 43.3H × 18.9D (in)</td></tr>
</table>

10-2-2 EXTERNAL VIEW AND DIMENSIONS

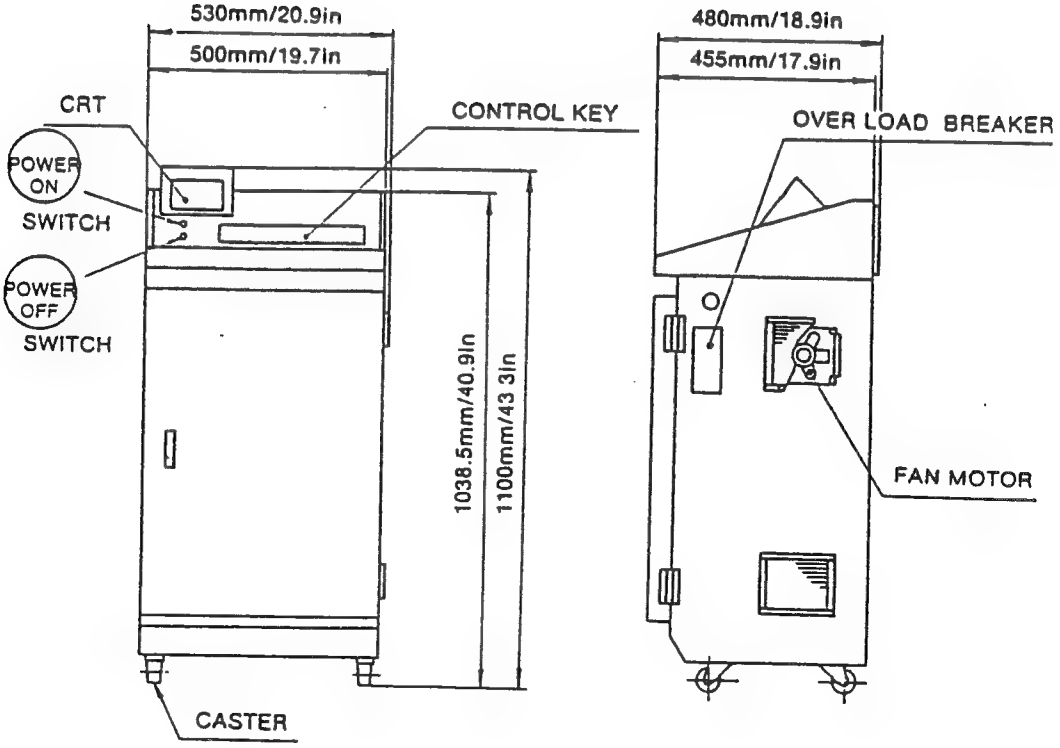


FIG. 10-3 Controller

10-3 OPTIONS

10-3-1 3RD JOINT (Z-AXIS)

Item	Specification	
Model	Moter type	Air cylinder type
Drive system	DC Servo Motor	Air cylinder
Rating	75V, 3.4A, 3,000 rpm	–
Encoder	Rotary, 1000 pulses/revolution	–
Transmission	Precision ball screw (lead 8 mm)	–
Movement	Linear slide	–
Stroke	150 mm/5.9 in	Standard: 100 mm/3.9 in Option: 10~200 mm/3.9~7.9 in
Speed	Max. 400 mm/sec/15.8 in/sec.	–
Weight	14 kg/30.8 lbs	2 kg/4.4 lbs
Note	Including: • Wireharness	Including: • Wireharness

10-3-2 4TH JOINT (R-AXIS)

Item	Specification
Model	Moter type
Drive system	DC Servo Motor
Rating	75V, 1.7A, 3,000 rpm
Encoder	Rotary, 500 pulses/revolution
Transmission	Harmonic Drive (Reduction ratio: 1/50)
Movement	Rotary
Operating angle	360°
Speed	Max. 360°/sec
Weight	2.5 kg/5.5 lbs
Note	Including: • Wireharness

10-3-3 COMBINATIONS OF 3RD AND 4TH JOINTS

Combination No.		1	2	3	4	5	6	7	8
3rd joint (Z-axis)	Air cylinder	–	O	–	–	O	O	–	O
	DC motor	–	–	O	–	O	–	O	O
4th joint (R-axis)	DC motor	–	–	–	O	–	O	O	O
Robot weight		30 kg 66 lbs	32 kg 70 lbs	44 kg 97 lbs	32.5 kg 72 lbs	46 kg 101 lbs	34 kg 75 lbs	46.5 kg 102 lbs	48 kg 106 lbs
Rated load capacity		10 kg 22 lbs	8 kg 17.5 lbs	10 kg 22 lbs	7.5 kg 16.5 lbs	8 kg 17.5 lbs	6 kg 13 lbs	7.5 kg 16.5 lbs	6 kg 13 lbs

— MEMO —

10-3-3-1 EXTERNAL VIEW AND DIMENSIONS

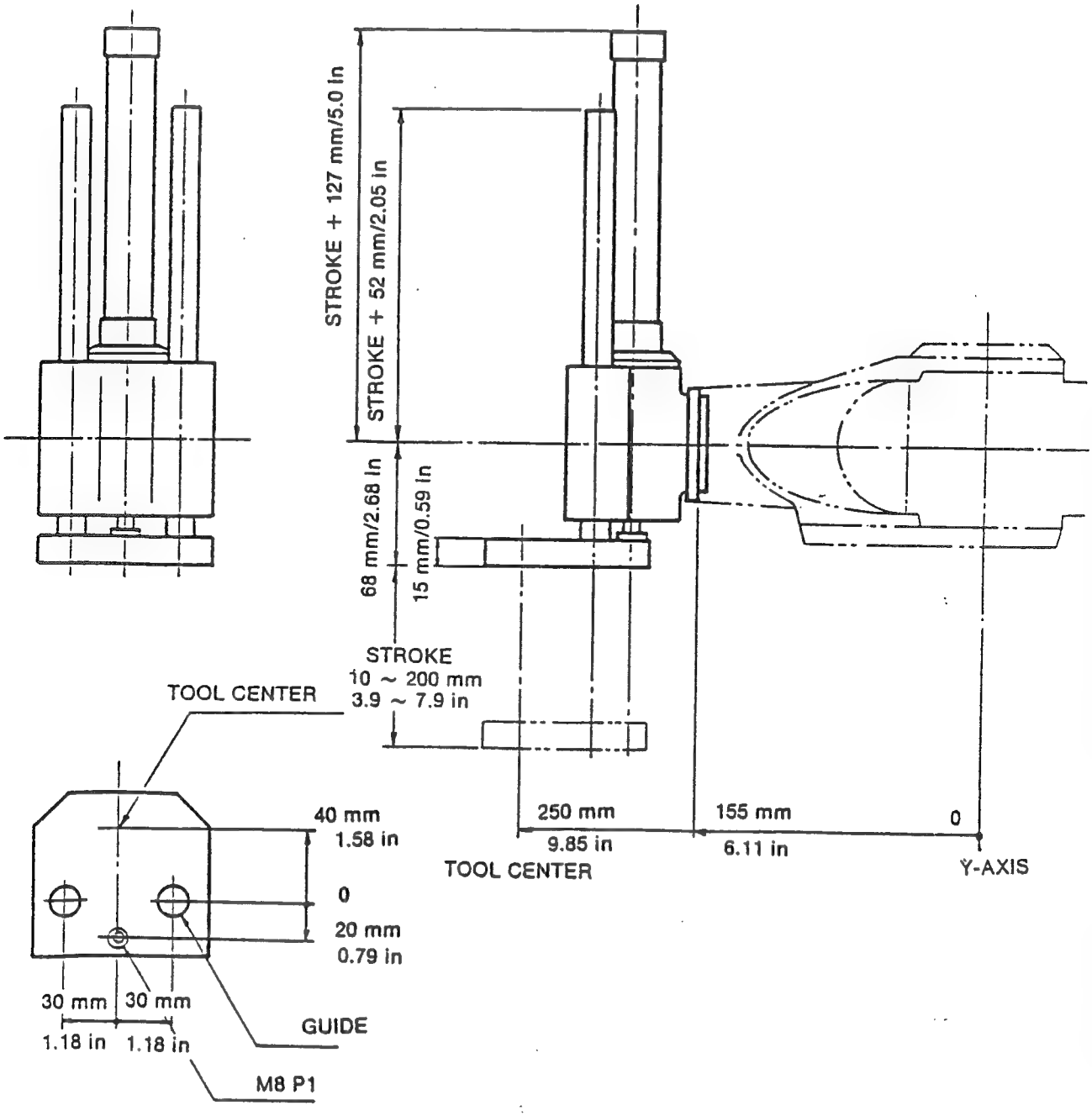


FIG. 10-4 Z-axis Unit (Air Cylinder Type)

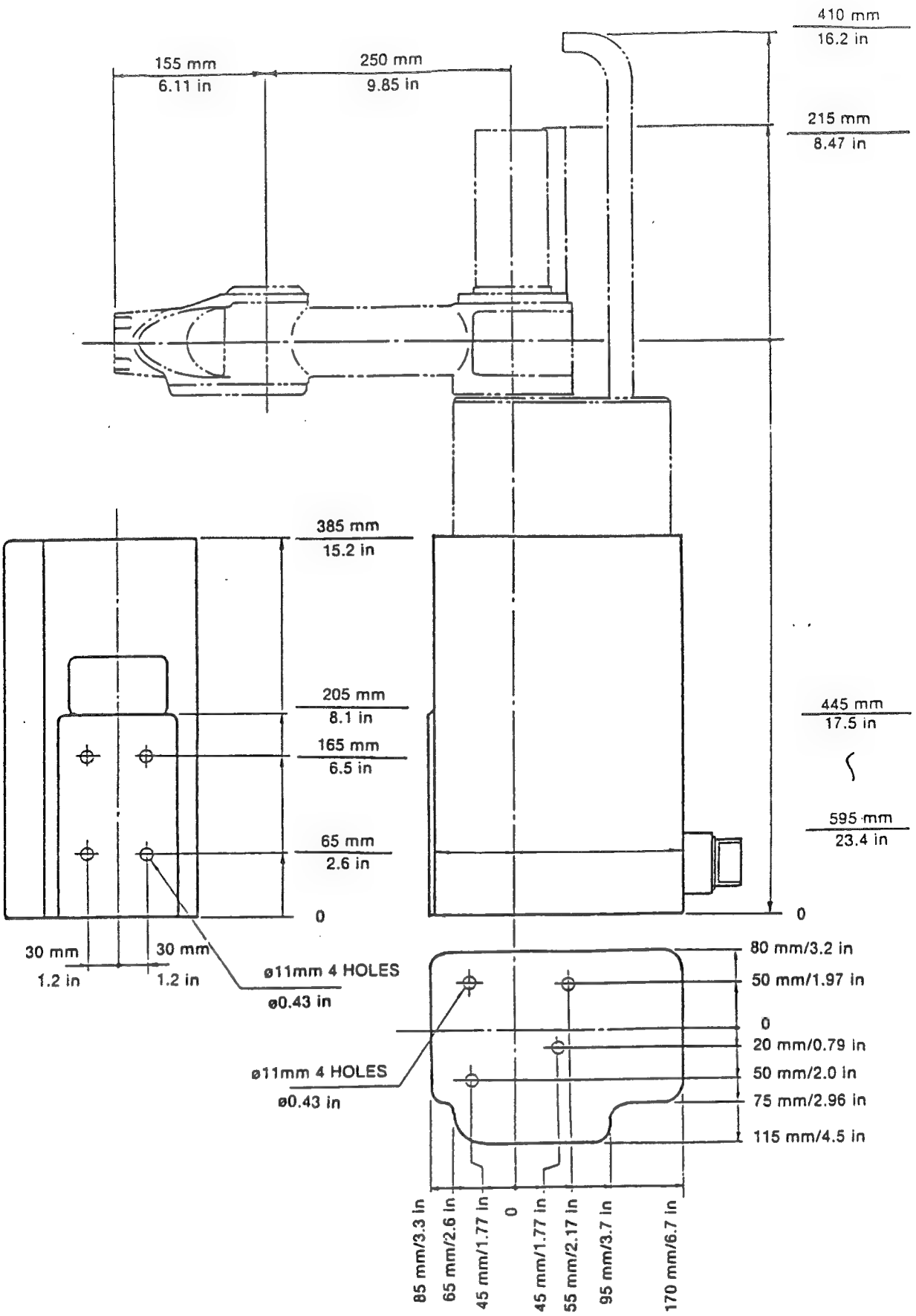


FIG. 10-5 Z-axis Unit (DC Servo Moter Type)

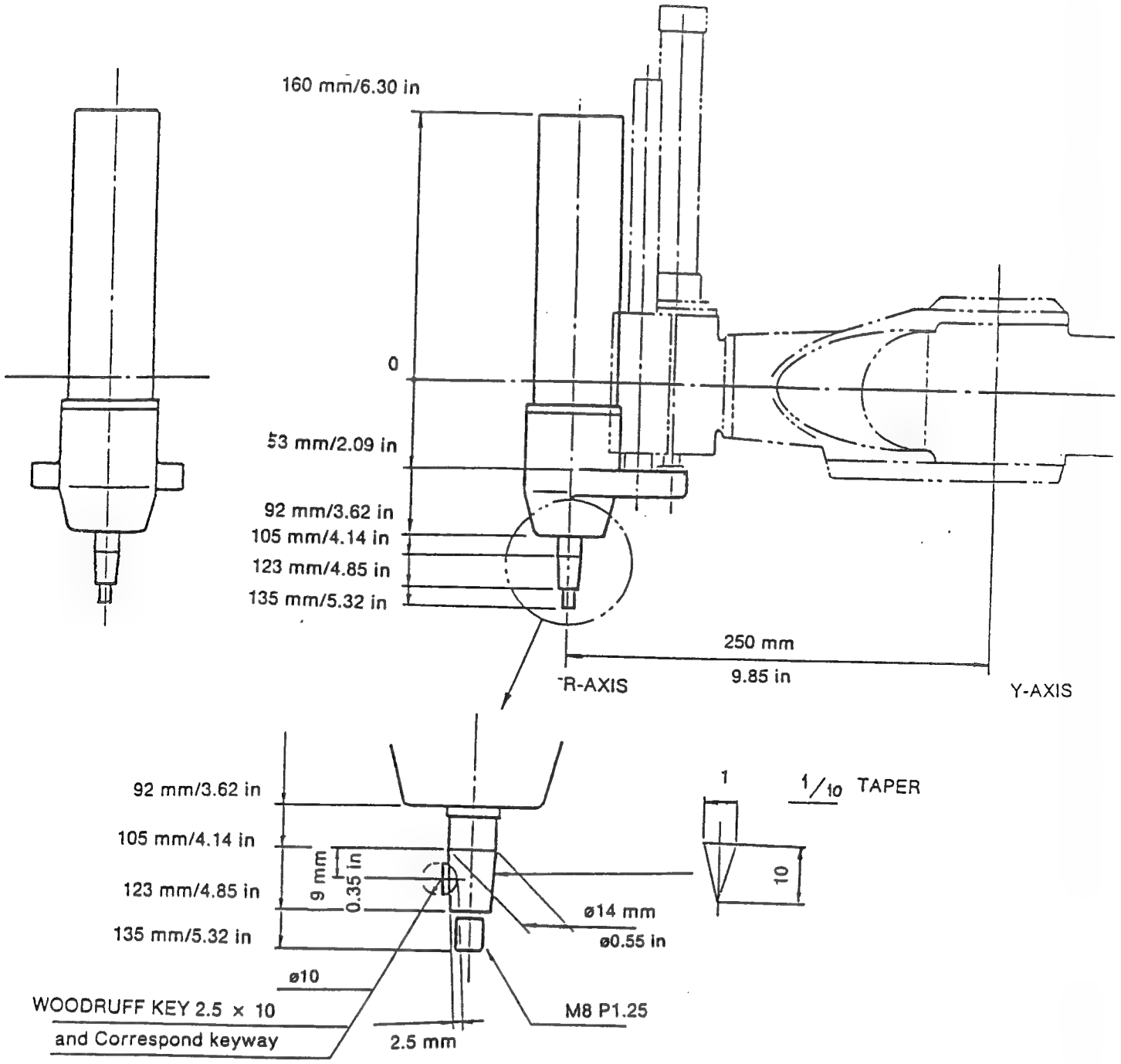


FIG. 10-6 R-axis Unit

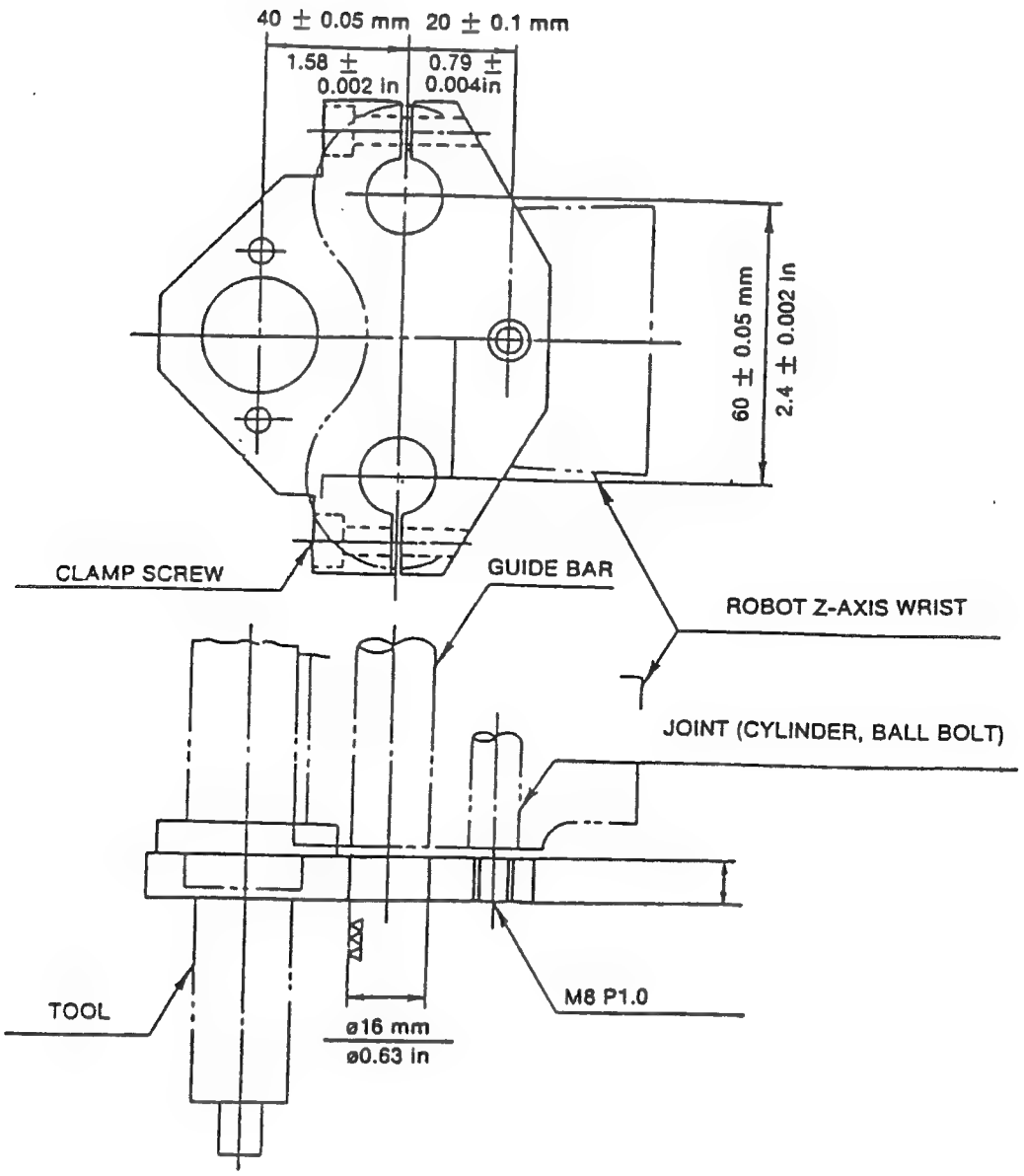


FIG. 10-7 Example of Tool Plate

10-3-5 TEACH PENDANT

Function	Manual arm operating and point data teaching
Dimension	110W × 50H × 180D (mm)/4.3W × 2.0H × 7.1D (in)
Weight	1.5 kg/3.3 lbs
Supplied cable	5 m/197 in
Display	Light Emitting Diode (LED), 7 segment

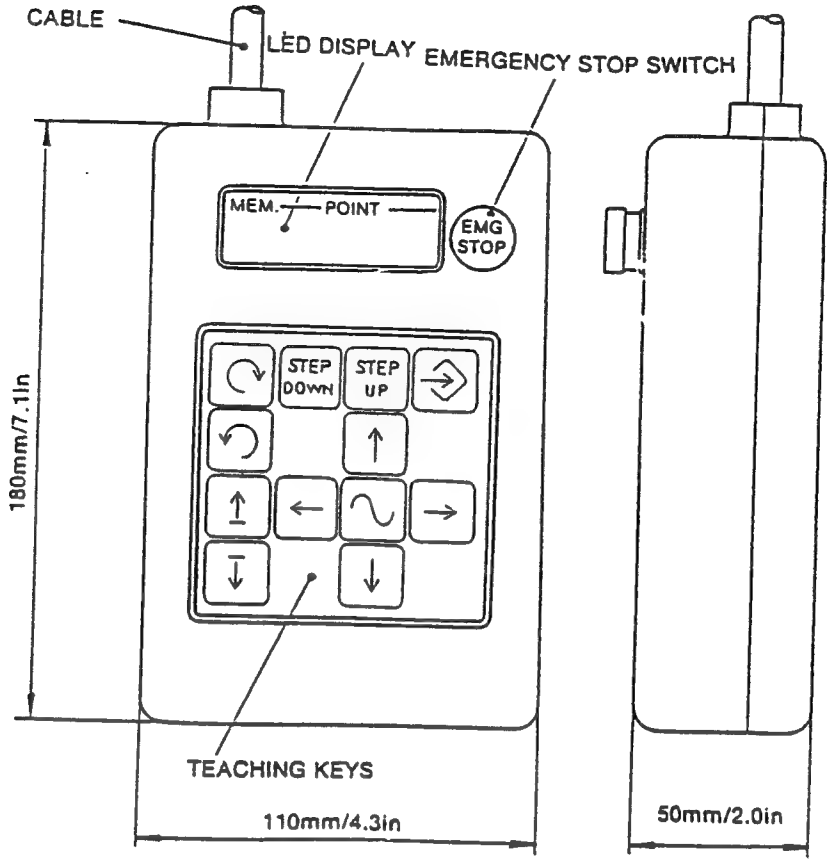


FIG. 10-8 Teach Pendant

10-3-6 EXTERNAL MEMORY STORAGE AND PRINTER

Function	Memory storing and printing
Dimensions	355W x 160H x 465D (mm)/14.0W x 6.3H x 18.3D (in)
Weight	10 kg/22 lbs
Supplied cable	5 m/197 in
Memory	Bubble memory cassette
Memory capacity	128 K Bytes
Printer	Line-dot thermal printer
Number of character	40 characters/line

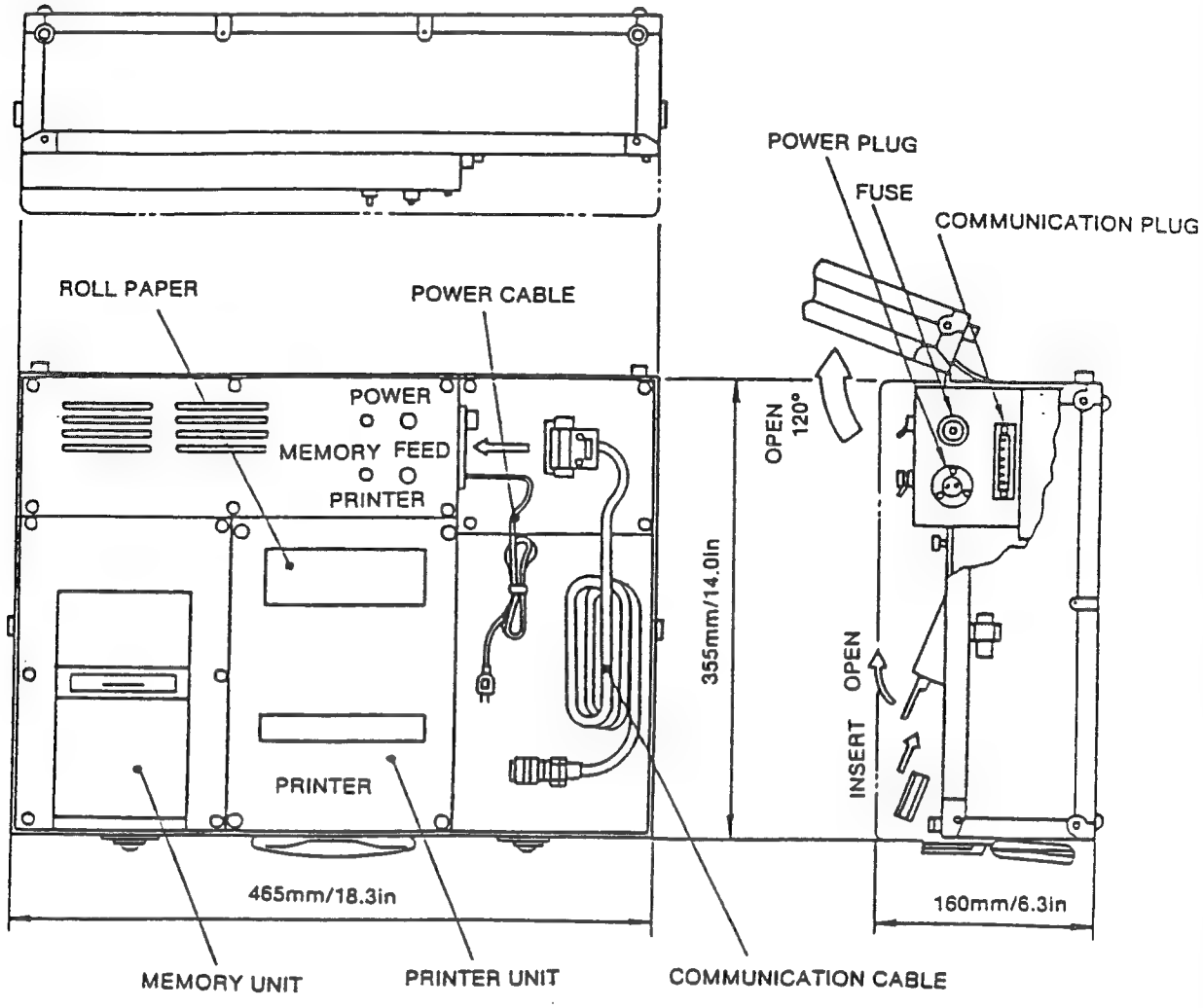
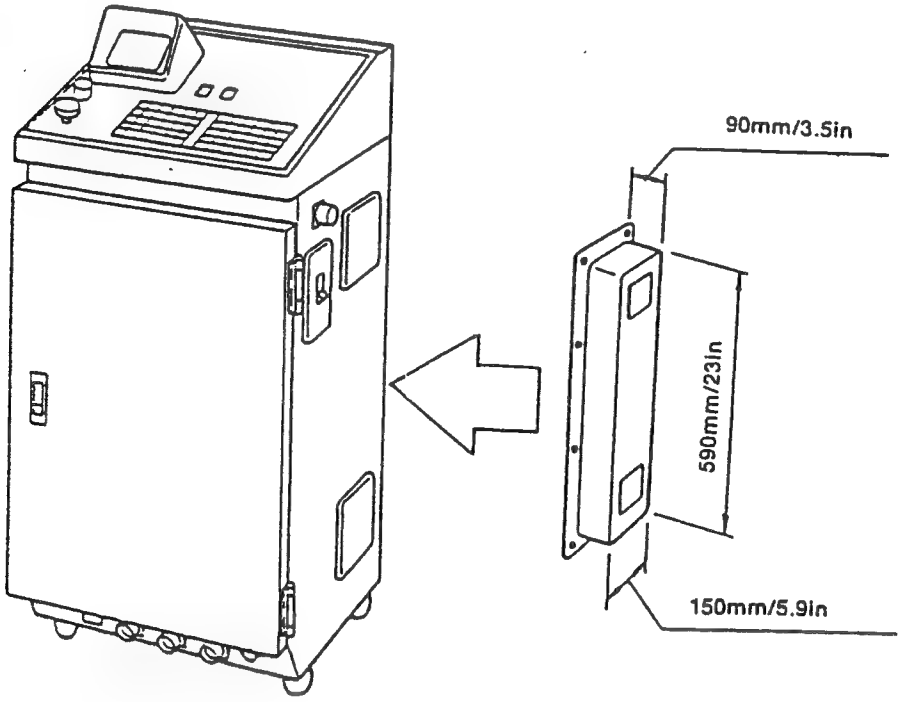


FIG. 10-9 External Memory Storage and Printer

10-3-7 INDIRECT COOLING UNIT

Function	Controller inner cooling
Dimention	150W × 590H × 90D (mm)/5.9W × 23H × 3.5D (in)
Weight	5.2 kg/11 lbs
Power source	AC 100V, 50/60 Hz
Contents	Cooling fan (motor) × 2, Cooling fin (aluminum)



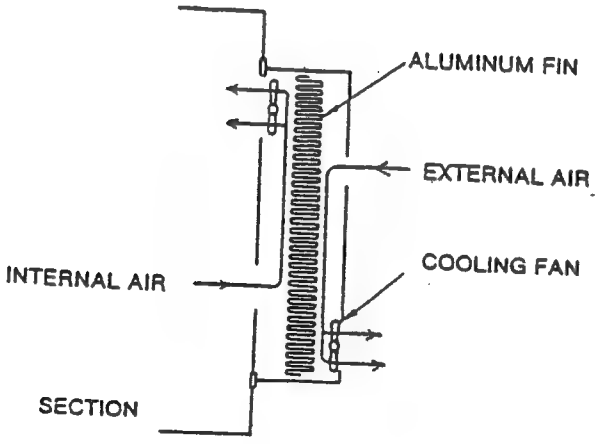


FIG. 10-10 Indirect Cooling Unit

APPENDICES

TROUBLESHOOTING

NO.	SYMPTOM	CAUSE	REMEDY
1.	An electrical shock is given when touching the controller.	· Internal electric leakage.	· Ask distributor to service.
2.	Controller will not power on.	· The power plug is removed. · Over load breaker (NFB) is turned off. · Specified voltage is not supplied. · Disconnection of power supply cable	· Plug in the power supply correctly · Turn on the overload breaker. · Supply the specified voltage. · Rearrange the power supply cable.
3.	Controller is powered on but the pilot lamp of switch is not lit.	· The pilot lamp bulb is defective.	· Replace the bulb.
4.	Controller is powered on but the screen is not displayed.	· Incorrect adjustment of the CRT brightness · Defective CRT	· Adjust the brightness. · Replace the CRT. (Ask distributor.)
5.	When power is on, the "SECOND LIMIT OVER" message is displayed on the screen and the operation cannot be made even within the set range of Robot motion.	· The manipulator is not connected with the controller. · The proximity switch for second travel limit is defective. · The fuse (5A) on I/O board is burned out. (In this case, all LEDs on the I/O board go out.)	· Connect the manipulator with the controller correctly. · Replace the proximity switch. (Ask distributor.) · Replace the fuse (5A).
6.	When power is on, the "HALT RECEIVED" message is displayed on the CRT.	· The HALT terminals on the I/O board are open.	· Insert a short bar between the DI 10 and COM (−) terminals on the I/O board. (Refer to Chapter 6) or turn on the DI 10 of the I/O CN 1.
7.	As soon as power is on, the manipulator starts running at a high speed.	· Incorrect connection or disconnection of tacho generator lead. · Incorrect connection or disconnection between the manipulator and controller	· Make connection correctly. In the case of disconnection, replace it. (Ask distributor.)
8.	As soon as power is on, the manipulator starts running at a extremely low speed.	· Incorrect connection or disconnection of encoder lead. · Incorrect connection or disconnection between the manipulator and controller · The standard parameter No. 20 has been set to "1".	· Make connection correctly. In the case of disconnection, replace it. (Ask distributor.) · Set the standard parameter No. 20 to "0" or perform the parameter initializing.
9.	The manipulator will not move even when operating the manipulator-driving key in Manual Mode.	· Incorrect connection or disconnection of motor lead · Incorrect connection or disconnection between the manipulator and controller	· Make connection correctly. In the case of disconnection, replace it. (Ask distributor.)
10.	When touching the manipulator-driving key or "*****" key, the "INTERLOCK" message is displayed on the screen and it will not operate.	· The interlock terminals on the I/O board are open.	· Insert a short bar between DI 11 and COM(−) terminals on the I/O board (Refer to I/O BOARD.) or turn on the DI 11 of the I/O CNI.
11.	When touching the "*****" key and performing Return to Home (Origin) position operation of the manipulator, the manipulator continues rotating clockwise until the "SECOND LIMIT OVER" message is displayed on the screen.	· The Return to Home (Origin) position operation is performed when the manipulator is located in the clockwise area viewed from the Home position. · Incorrect adjustment of Home position dog.	· Check the Home position before performing the Return to Home position operation from the counterclockwise area on both 1st and 2nd arms (X and Y axes). · Adjust the Home position dog again.
12.	No matter How many times the Return to Home (Origin) position operation of the manipulator are performed by touching "*****" key, the manipulator rotates counterclockwise, the "BAD POSITION" message is displayed on the screen, and the operation stops.	· Defect or disconnection of proximity switch.	· Replace the proximity switch. (Ask distributor.)
13.	In the operation with the control key, the reaction is very slow.	· Incorrect the drift adjustment of the motor driver unit. · Because the allowance of indication point is smaller than minimum set value, the indication point is not easily found.	· Make the drift adjustment of the driver unit. (Refer To Chapter 7. "ROBOT ADJUSTMENT".) · Expand the parameter allowance to 8 pulses or more. (Refer to Chapter 7. "ROBOT ADJUSTMENT".)

TROUBLESHOOTING

NO.	SYMPTOM	CAUSE	REMEDY
14.	When touching the "RUN" key in the Operation Mode, the "ERROR" message is displayed on the screen and the specified program is not performed.	· In the case of the "ERROR" display: misprogramming.	· Correct the program according to error messages.
15.	When touching the "RUN" key in the Operation Mode, the "RUNNING" message is displayed on the screen and the specified program is not performed.	· In the case of the "RUNNING" display: EMERGENCY STOP operation is carried out in the preceding operation (while the Robot is operating) or the operating program is halted by powering off.	· Perform the reset operation. (Refer to Chapter 4. "OPERATION".)
16.	During the "AUTO" operation, the "ERROR" message is displayed on the screen and the operation stops.	· In the case of the "ERROR" display: a. Misprogramming b. Various abnormalities occur. c. The signal "HALT" or "INTERLOCK" is being input from external devices.	· Take action according to error messages for items a and b. · Cancel the external signal "HALT" or "INTERLOCK" for item c.
17.	During the "AUTO" operation, the "MANUAL" message is displayed on the screen and the operation stops.	· In the case of the "MANUAL" display: Power is off instantaneously or the voltage decreases below the allowable level for the controller operation.	· Check the power supply and secure the specified voltage.
18.	The "MOTOR DRIVER" message is displayed on screen, no operation is made, the green LED (run) on the driver unit of each motor goes out, and the LED (red) lights that indicates the abnormal point.	· The motor driver unit in the controller detects any abnormality. "OC" (over current) lights: Abnormal current flows through the motor. "OL" (over load) lights: Abnormal load is applied to the motor. "OS" (over speed) lights: The motor rotates with an abnormal speed. "TF" (tacho generator fault) lights: The difference between values of specified motor revolution and feedback is extremely large. "PF" (power source fault) lights: Power supply voltage is extremely decrease.	· Check the abnormal point with the LED (red) before powering off, and take action as follows: In the case of "OC", "OS", and "TF": Ask distributor. In the case of "OL": Decrease the load and check if the manipulator is mechanically locked. In the case of "PF": Check the power supply voltage and capacity. If the same phenomenon often occurs when powering on again, ask distributor.
19.	The manipulator misses the specified location.	· During the Robot operation, the manipulator collides with something and a strong force is given to it, that causes the manipulator to miss the target. · The manipulator deviates by a turn of the motor because of incorrect initial calibration. · The specification of shift coordinates is incorrect.	· Calibrate the deviation of the manipulator before creating the point data again. · Adjust the initial calibration again. · Correct the program. (Refer to Chapter 5. "PROGRAMMING".)
20.	· While the Robot operates, the manipulator deviation is getting larger.	· Defective encoder.	· Replace the encoder. (Ask distributor.)
21.	While the Robot operates, the manipulator vibrates abnormally.	· The parameters are not set correctly. · Looseness, abrasion, or breakage of the manipulator driving mechanism.	· Reset the parameters for weight and speed to proper values. · Ask distributor.
22.	While the Robot operates, the manipulator produces abnormal noises.	· Looseness, abrasion, breakage, or shortage of grease of the manipulator driving mechanism.	· Tighten each point and apply grease to it. (Ask distributor.)
23.	As soon as power is on, the "MEMORY DESTROYED" and "PARAMETER DESTROYED" message are displayed on the screen, and the Robot will not operate.	· The back-up battery is discharged and the memory is destroyed because the power has not been on for two weeks or more.	· Initialize the parameter memory and input the parameters and program again. (Refer to Chapter 4. "OPERATION".) After inputting them, power on for 40 hours or more to charge the back-up battery.

NO.	SYMPTOM	CAUSE	REMEDY
24.	External devices (push buttons, sensors, solenoid valves and so on) connected with the I/O interface will not operate correctly.	· Incorrect connection. · The power supply of 24 V DC is used with more than 2 A. · The fuse is blown. · Defective I/O board	· Connect them correctly. (Refer to Chapter . "INPUT/OUTPUT INTERFACE".) · Use it with 2 A or less. · Replace the fuse and check the connection of the I/O interface. · Replace the I/O board. (Ask distributor.)

RROR CODE	ERROR MESSAGE	MEANING	POSSIBLE CAUSES	REMEDY
3	FILE DESTROYED	Bubble memory data was destroyed.	a. Bubble cassette is not initialized. b. Power source was off when saving data into bubble cassette.	Initialize bubble cassette again.
4	PROGRAM DESTROYED	The presently selected program is bad.	a. Power was switched off during automatic operation. b. The whole memory is bad.	1. Re-edit only that program. 2. Erase only that program. 3. Initialize the whole memory.
5	POINT DESTROYED	Bad point data	a. Power was switched off while editing point data. b. Power was switched off during automatic operation. c. The whole memory is bad.	1. Erase only the bad point data. 2. Erase any one of the point data. 3. Erase all point data. 4. Initialize the whole memory.
6	SECOND LIMIT OVER	The robot has moved up to the second limit switch.	a. The 1st limit setting is faulty. b. Faulty point data	1. Set the 1st limit within the 2nd limit. 2. Take care that the point data do not exceed the 2nd limit.
7	MOTOR DRIVER ERR	Malfunctioning of the servo motor driver.	a. Motor overcurrent b. Motor overload c. Motor speed too high d. AC voltage drop e. Tacho generator malfunction etc.	1. Turn off power, then turn on again. 2. Check the servo motor driver, motor cable and motor. (Refer to troubleshooting chart).
9	CPU BUS LOCK	The CPU has halted because an address without a program has been accessed.	CPU out of control	1. Turn off power, then turn it on again. 2. Replace CPU PCB. (Refer to troubleshooting chart.)
10	CANNOT EXECUTE	User program includes an undefined command statement.	a. Bad user program execution order b. Bad program	1. Check user program execution order. 2. Erase program.
11	RUNNING	Indicates that an user program is being run. This is not an error.	a. The "RUN" key has been touched. b. The DI automatic start signal has been activated.	—
12	REMOTE STOP	Indicates that an emergency stop has been performed from the teaching box.	The emergency stop key on the teaching box has been pressed.	—
20	NUMBER ERROR	Inappropriate number value	Mistaken key entry of number.	Repeat entry using an applicable number value.
21	PORT NUMBER ERROR	Faulty port number	Port number was except 2 ~ 5 for DI and except 1 ~ 3 for DO.	Use correct port number.
29	HALT RECEIVED	A halt signal has been inputted from the external devices.	An external halt signal has been inputted to the robot DI.	—
30	INTERLOCK	An interlock signal has been inputted to a robot DI.	Ditto	—
32	ORIGIN INCOMPLETE	The Home Position is not defined. (Return to Home Position has not been completed.)	Return to Home (Origin) Position was not performed after turning on power.	Perform return to Home (origin) Position.
33	NO STD COORDINATES	Standard coordinates have not been set.	Bad memory	Initialize memory and set standard coordinates.
34	X BAD POSITION	The present 1st arm (X-axis) position is too close to the origin.	a. Return to Home (Origin) Position was attempted from a position too close to the origin. b. Bad Home Position dog c. The Home Position signal line is interrupted.	1. Deep a distance of at least 10,000 pulses from the Home Position in the "+" direction. 2. Check the Home Position dog. 3. Check the signal line.

ERROR CODE	ERROR MESSAGE	MEANING	POSSIBLE CAUSES	REMEDY
35	Y BAD POSITION	The present 2nd arm (Y-axis) position is too close to the Home Position.	a. Return to Home (Origin) Position was attempted from a position too close to the origin. b. Bad Home Position dog. c. The Home Position signal line is interrupted.	1. Deep a distance of at least 10,000 pulses from the Home Position in the "+" direction. 2. Check the Home Position dog. 3. Check the signal line.
36	Z BAD POSITION	The present 3rd joint (Z-axis) position is too close to the Home Position.	Ditto	Ditto
37	R BAD POSITION	The present 4th joint (R-axis) position is too close to the Home Position.	Ditto	Ditto
50	READ ERROR	Bad loop on bubble memory	a. Unsuitable power source b. Power line noise or electromagnetic noise	Write loop data again.
51	ACCESS ERROR	Number of bad loop is abnormal.	Ditto	Ditto
52	PAGE SIZE OVER	No room in bubble memory	—	—
53	WRITE PROTECTED	Write protecting switch on the bubble cassette is on.	—	Off the write-protecting switch.
54	CASSETTE OFF	Bubble cassette was not loaded in the holder.	—	Load bubble cassette into holder exactly and close holder cover.
55	TRANSFER ERROR	Signal timing error when transmitting.	Unsuitable power source or noise	Try again.
56	INTERFACE DATA ERROR	Communication parameter unmatched.	a. baud rate unmatch b. word length unmatch	Set parameter correctly.
57	EJECT ERROR	Bubble cassette has not been loaded into holder when accessing.	—	Try again after loading cassette.
101	FORMAT ERROR	Faulty entry format	—	Enter using correct format.
102	DATA ERROR	Faulty numeric data format	—	Enter using correct format.
103	COMMAND ERROR	Bad command word	—	Use defined command words.
107	DIGIT NUMBER ERROR	Mistake in the number of digits.	—	Enter using correct number of digits.
111	LABEL TOO MUCH	The number of labels used exceeds 99.	Incorrect user program	Decrease number of labels to 99 or less.
112	UNDEFINED LABEL	A label used in a "CALL" or "GOTO" statement has not been defined in the program yet.	Incorrect user program	Correct program.
113	MULTIPLE-DEFINED	The same label has been defined at 2 different locations in the program.	Incorrect user program	Use different label.
114	FOR VARIABLE ERR	Faulty variable in "FOR" statement	—	Use alphabetical characters other than "I", "O" or "P".
115	NEXT WITHOUT FOR	A "NEXT" statement has been used without a corresponding "FOR" statement.	Incorrect user program	Use "FOR" and "NEXT" statements in the correct order.
116	RETURN WITHOUT CALL	A "RETURN" statement has been used without a corresponding "CALL" statement.	Incorrect user program	Use "CALL" and "RETURN" statements in the correct order.
117	OVERFLOW	An overflow has occurred during calculation.	Faulty calculation formula	Correct calculation formula.
118	DIVISION BY 0	A division by 0 has been attempted.	The variable value of a divisor is 0.	Change the user program so that the divisor does not become 0.

ERROR CODE	ERROR MESSAGE	MEANING	POSSIBLE CAUSES	REMEDY
119	MEMORY FULL	No memory space left to store a new user program or point data.	—	Erase an unnecessary user program or an unnecessary point.
120	NO POINT	A point has not been defined.	a. An user program was run without defining points. b. Faulty user program	1. Recreate point data. 2. Check user program.
121	BAD VARIABLE	Faulty variable format in the executed line.	Bad user program	1. Correct or erase user program. 2. Initialize whole memory.
122	DATA TYPE ERROR	Attempted addition or subtraction of point data using a differing system of coordinates.	—	See that data to be added or subtracted uniformly corresponds to either joint coordinate or XY coordinate.
123	SOFT LIMIT OVER	Arm or joint has reached the first travel limit (soft limit).	a. Unsuitable soft limit setting b. Mistaken user program	1. Change the soft limit setting. 2. Correct user program.
124	BAD XY DATA	The XY coordinate values cannot be converted into joint coordinate values.	a. Mistaken point data b. Mistaken setting of shift coordinates	1. Correct point data. 2. Correct shift coordinates.
125	COMMUNICATION ERR	Communication error	a. Baud rate unmatch. b. Parity unmatch c. Turning off the power source of the external memory unit. d. Bubble memory device doesn't respond.	—
130	FILE NOTHING	No file name	—	Enter the file name before save/load/erase.
131	VERIFY ERROR	The current controller's memory data differs from the bubble memory data.	—	If this error occurred continuously, call distributor.
150	STOP EXECUTED	Execution of an user program has been completed.	A STOP statement has been executed.	(This is not an error.)
160	DEVICE ERROR	The PRINTER/MEMORY switch of the device is turned to the wrong side.	—	Turn the switch to correct side.
199	PROGRAM EXISTS	The specified user program already exists.	—	—
200	NO SUCH PROGRAM	The specified user program does not exist.	—	—
202	STACK OVERFLOW	The stack area used for executing an user program has overflowed.	There is a mistake in the user program, i.e. in the usage of a "CALL" statement.	Change user program.
203	MEMORY DESTROYED	The user program storage memory is bad.	a. Drop in power failure back up battery voltage b. CPU out of control c. Bad memory	1. Initialize memory 2. Replace CPU PCB. (Refer to troubleshooting chart.)
204	PARAMETER DESTROYED	Bad parameter	Ditto	1. Initialize parameters. 2. Replace CPU PCB. (Refer to troubleshooting chart.)
Manual Mode Message	BATTERY NEEDS CHARGING	The power failure back-up battery is not sufficiently charged.	a. Robot not used frequently enough. b. Battery has deteriorated.	1. Turn on power until battery has been recharged (over 8 hours). 2. Replace battery. (Refer to troubleshooting chart.)
240	POWER FAILURE	Power failure	—	—